BLOCK SIGNAL OPERATION

A PRACTICAL MANUAL

BY

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PREFACE.

In submitting this work to the railroad and engineering public the writer wishes to disclaim any thought of proposing original ideas, his aim being simply to present the latest practice in block signal operation that obtains in this country and in Europe. The only pretension to originality is in connection with "A Method of Single Track Blocking" described in Chapter X., which, it is believed, embodies features that will ensure the holding, at the proper passing sidings, of trains to be met by opposing trains. Neither is any attempt made to discuss the relative merits of the different systems of blocking, nor to give more than a general description of the apparatus used in carrying out the block principle, except where details seem to be necessary to a proper understanding of the operating rules.

PREFACE.

As the block system has been in use in England almost from the beginning of railroads, the English practice of to-day is the result of a long experience by which the railroads of this country should not fail to profit, and on this account somewhat more space is devoted to English rules and methods than would otherwise seem necessary.

Thanks are due and are gratefully extended to the following gentlemen who have furnished much of the information contained in these pages: Mr. Geo. P. Neele, ex-Superintendent of the line, London & North Western Railway; Mr. Edgar Van Etten, General Superintendent, New York Central & Hudson River Railroad; Mr. Charles R. Fitch, General Superintendent, Erie Railroad; Mr. C. H. Platt, General Superintendent, New York, New Haven & Hartford Railroad; Mr. O. M. Shepard, Superintendent, New York, New Haven & Hartford Railroad; Mr. Henry Johnson, of the Standard Railroad Signal Company; Mr. Wm. P. Hall, President, and Mr. W. W. Salmon, Engineer and Western Agent of the Hall Signal Company; Mr. A. W. Sullivan, General Superintendent, Illinois Central

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CHAPTER I.

INTRODUCTORY.

Trains are ordinarily moved according to a "time-table," which is "the general law governing the arriving and leaving time of all regular trains at all stations." Before a train leaves its starting point, however, the dispatcher is notified by telegraph, so that he can issue special telegraphic orders to the train if this is desirable.

Trains are directed by such telegraphic orders whenever it is deemed advisable to depart from the ordinary rules and the time-table, as for instance, when a train on single track falls behind its regular schedule, and thereby fails to reach a time-table meeting point at the scheduled time. In order to prevent delay to the opposing train or trains the meeting is changed from the scheduled point to a more

convenient one, by special orders addressed to those in charge of the trains affected. Another case is when a superior train on either double or single track becomes late. To prevent delay by other trains waiting for the overdue train, the latter is directed by special orders to run a certain time later than its regular time schedule, the dispatcher having set back (for that day) the schedule of the train between the points named for a certain time stated in the orders. Copies of the orders are given to other trains, so that these can be governed by the later time instead of by the regular schedule.

Other cases calling for the use of special orders are those of the passing of a fast train around a slower one, both moving in the same direction; the governing, with reference to other trains, of the movements of work trains or other irregular trains; and the governing of any other irregular movements.

This method of directing the movements of trains is called "train dispatching." The dispatcher keeps a record of each train on what is known as the "train sheet." This record consists of the number of the train and of the engine, the names of the conductor and engine-man, the number of each kind of cars in the train, the time of the train's departure from the starting point, of its arrival and

departure at the principal intermediate stations and of its arrival at the destination. By the train sheet, therefore, the dispatcher can at all times quickly locate the train and determine the time that it will probably arrive at a distant station.

Under the "double order system," which is considered to be by far the safest method of train dispatching, each person or train affected by an order receives a copy of it, or, in the words of the standard code, "each order must be given in the same words to all persons or trains directly affected by it, so that each shall have a duplicate of what is given to the others." So strictly is the duplication of orders carried out in this method that an operator must, in case he did not originally make a sufficient number of copies at one time, trace from a copy which has been approved by the dispatcher the additional copies required. A few of the other principal points governing the issuing of telegraphic train orders under this method are as follows:

The orders must not contain instructions not essentially a part of them. They must be brief and clear. They must be addressed to those who are to execute them, naming the place at which each is to receive his copy; each person addressed must be supplied with a copy. Orders once in effect continue so until ful-

filled, superseded or annulled. The delivery of orders to those who are to execute them carries with it permission to pass the train-order signal at "danger" at that point, but does not confer any right to pass the block or other signals at "danger."

The "time-limit system" is a method of keeping trains a certain length of *time* apart, and is so named in contradistinction to the "block system," which keeps trains a certain *distance* apart. By the time-limit system a train is held at a station a certain time behind a preceding train, the procedure under the standard code of the American Railway Association being as follows:

When a train of inferior class meets a train of superior class on single track, the train of inferior class must take the siding and clear the train of superior class five minutes. A train of inferior class must keep five minutes off the time of a train of superior class following. Passenger trains running in the same direction must keep not less than five minutes apart. Freight trains following each other must keep not less than five minutes apart.

On many roads the minimum time between trains is extended, usually to ten minutes.

The time-limit system is defective in that it presupposes a machine-like regu-

larity in the movement of trains, which does not and cannot exist. In itself it affords little or no protection to slow trains against being overtaken between stations by fast trains. But its especially weak point on single track is that it offers no safeguard worth mentioning for head-to-head movements, and none whatever against error in or misunderstanding of orders in regard to irregular meeting points. The absolute block system does protect trains under these circumstances, by keeping them a certain distance apart.

In viewing the subject of block signalling in a general way, care must be taken not to confound the instruments for carrying out the block principle with the principle itself. Broadly speaking, the block system, or what would seem a more appropriate name, the *space* system, is the maintaining of a space between trains while running on the line.

The actual operation of the block system dates from December, 1839, when the Great Western Railway, of England, began telegraphing the arrival and departure of its trains from station to station for a short distance, near London. This was at the suggestion of Messrs. Cooke and Wheatstone, who, in 1841, intro-

duced separate instruments for each direction of traffic, showing whether the sections were clear or blocked. They also added telegraph bells.

The first well-authenticated published suggestions of the block system were contained in a pamphlet printed in 1842, entitled "Telegraphic Railways," by Mr. (afterwards Sir) W. F. Cooke, an English engineer. He laid down the following principles:

"Every point of a line is a dangerous point, which ought to be covered by signals. The whole distance, consequently, ought to be divided into sections, and at the end as well as the beginning of them, there ought to be a signal, by means of which the entrance to the section is opened to each train when we are sure that it is free. As these sections are too long to be worked by a traction rod they ought to be worked by electricity. At the end of each section of from two to two and a half miles, a line-keeper is stationed in a hut, with a turning disk, or a semaphore. In each hut there ought to be two telegraphs with magnetic needles, the one on the right hand being in communication with that on the left of the neighboring hut. The needle telegraph can only give two signals: 'Line clear,' or 'line blocked.'"

It will be noted that this embodies all the leading features of the block systems of to-day. The constantly increasing volume of business on railroads soon made it necessary to improve the means for securing safety in operation, and in 1851 Mr. C. V. Walker, of the South Eastern Railway, of England, devised the method of signalling by electric bells, the signals being by sound only, no needle instruments being used. In 1854 the London & North Western Railway introduced separate instruments for each track, with three positions of the needle, and later used the bell code in connection therewith. Subsequently automatic block signals were invented and brought into use, and they are now used more extensively in the United States than in any other country.

The Sykes system of block signalling was invented in 1875. In this method the out-door signals at a block station are controlled by the signal-man at the station in advance, by means of electrically-operated locks, the locking apparatus at the two stations being connected by an electric circuit. This effects a decided check against mistakes or carelessness, for while each signal-man operates his own signals, he cannot operate them until they have been unlocked by the signal-man in advance, on request of the first signal-man.

The block system was introduced into the United States by the Pennsylvania Railroad about 1876, and has since been adopted in whole or in part by the Erie, the New York Central & Hudson River, the Chicago, Milwaukee & St. Paul, the Illinois Central and other railroads. It is also used on many railroads for the protection of junctions, draw-bridges, etc., and of parts of the line where there are heavy descending grades or sharp curves.

It is hardly in the province of a work of this kind to consider in detail the question of which of the different types of blocking is best suited to a particular situation.

At junctions, and at railroad crossings at grade, where there are interlocked switches and signals the manual type will probably be operated, because of the necessity of having an attendant to operate the track switches (points) and signals, which should be operated in unison with the block system, no matter which type is used. At passing sidings on single track lines the manual type will be used, because it is necessary always to have a distinct understanding between persons at different passing sidings as to whether it is all right for a train to make a contemplated movement.

The manual type requires the constant employment of an attendant at each block station to operate the signals, and of a small force to inspect and maintain the signals at the different stations. In hours when the traffic is light, however, as at night, some of the block stations can be closed. The consequent saving in attendants' wages is considerable, and the only effect on the service is that the blocks, being longer, take more time to clear. In the manual type comparatively expensive station buildings have to be provided, for housing the attendant and the signal machinery.

The following are items of expense in the manual type: Block station buildings; electric bells with keys, batteries and wire circuits for code signalling between the different stations, and between stations and outlying switches; out-door signals, including the posts, signal levers, interlocking, foundations, signal wires with pulleys, stakes and posts for supporting the wires, and signal wire compensators; and, when used, electric locking apparatus, including the wire or the track circuit, for controlling the out-door signals. The out-door signals should be a distant and a home signal for each direction at points where there are no cross-overs or passing sidings, and a distant, home, and an advance signal for each

direction where there are cross-overs. Where there are passing sidings additional signals are required to govern the movements of trains from the siding into the block in advance. Signal repeaters for indicating to the signal-man the position of signals located out of his sight should be taken into account. In addition to these items of expense are wages of attendants, of inspectors and of linemen, cost of fuel and of material used in repairs and renewals, and interest on cost of plant.

In machine blocking the staff or tablet machines form an additional item of expense.

In estimating the cost of an automatic system these items of expense should be taken into consideration: Signals; electric circuits (track or wire); batteries; battery houses; track instruments for making and breaking the controlling operating circuit if a wire circuit is used; switch (point) instruments for connecting the switches with the signal circuit, so that when a switch is set for the side movement the signal circuit is broken and the block signal falls to "danger;" switch indicators, to be placed at switches to indicate to trains on sidings the condition of the blocks; instruments for so operating the block signal, as to protect a point where the main track is broken in the course of business, as at draw-bridges.

etc., by controlling the operating circuit; and battery supplies and other material used in the repairs and renewals of the plant. While attendants are not required to operate the signals in the automatic type, the employment of a corps of experienced linemen is necessary to keep the line and instruments in repair, renew the batteries, etc. There should also be taken into account the wages of an electrician, battery men, and of inspectors of the electrical apparatus, and the interest on the cost of the plant. If compressed air is used the following items are to be added: compressor engines and the necessary steam or other plant for running them; fuel, oil, etc., for the engines; piping for conveying the compressed air to the different block stations; and (for operating the signal blades) air cylinders with electrically-controlled valves for governing the admission of the compressed air.

In comparing the cost of the different systems of block signalling each item on account of construction, maintenance and operation must be considered. The first thing to be determined is the number of blocks into which the line is to be divided. It is estimated that a train running at the rate of 100 miles an hour requires a space of 2,500 feet in which to come to a stop, and as this speed is now very generally looked upon as the ideal speed to be aimed at, and has, in fact, been

actually attained in a few instances, it may have to be taken into consideration when arranging a block signal plant. Trains running at that speed would require the blocks to be at least nearly a half mile long. On the other hand, where the speed is lower, and especially in yards where trains are numerous but run at comparatively low speed, shorter blocks are desirable.

In all types of blocking the cost of interlocking for junctions and crossings is the same, if ordinary manual interlocking is used; therefore this item does not affect the comparative cost of the different systems of block signalling.

CHAPTER II.

GENERAL PRINCIPLES.

The block system is a method of keeping trains a certain distance apart. Under it the line is divided into blocks, or sections, the entrances to which are guarded by appropriate signals for the government of trains. The blocks may be of any reasonable length, depending on the physical characteristics of the line and on the amount of traffic—that is, the frequency with which trains are run. On lines with heavy traffic the blocks are often not more than a few hundred yards long, while with lighter traffic they may be from three to eight miles in length. They must not, however, be so short that the distant signal governing a block will overlap a signal of the next block in the rear, if this distant signal is so placed as to give a train a sufficient distance in which to make a stop before reaching the home

signal governing the block. For non-meeting purposes on single-track lines the blocks extend from one passing siding to another.

The same principles that govern double track blocking largely govern blocking on single track. In double track blocking, however, only the movements of trains in following each other have to be provided for, while single track blocking has to do this, and, in addition, guard against trains meeting head-to-head. Therefore, double track blocking may be distinguished by the general name of "non-following block," in contradistinction to that of "non-meeting block," for single track blocking.

The block systems generally used are the "manual," "controlled manual," "auto-manual," "automatic," and "machine."

In manual blocking the block, or out-door, signals at the entrance to each block are wholly controlled and operated by the signal-man at that station.

In controlled-manual blocking the block signals at the entrance to each block are controlled either electrically, as in the Sykes system, or mechanically, by the signal-man at the station in advance, but are operated by the signal-man at the entrance to the block.

In the auto-manual system the signals are in general operated as in the manual, or as in the Sykes, but are replaced in the "danger" position automatically by the train after the rear car passes them.

In automatic blocking the operation of the signals is entirely automatic, generally through the agency of electricity, or of a combination of electricity and compressed air. With this system, therefore, no signal-men are required.

Machine blocking is a method of controlled single track blocking in which are used, in connection with the ordinary out-door signals, certain machines with detachable parts and worked mechanically, except that they are unlocked electrically.

The principal benefits from the block system are increased safety for trains and economy and increased facility in train operation.

Increased safety is gained in three ways: (1) By keeping trains on the road an invariable distance apart, thus reducing to a minimum the risk of collision, either from trains overtaking each other, or opposing trains meeting on single track; (2) by the employment of signal-men, who have a full view of passing trains and of the tracks for a considerable distance, and being in regular communication with the track walkers and other watchmen, are often able to stop trains in time to

save serious trouble from defective train appliances and road-bed; (3) by trainmen and engine-men using greater vigilance, being alert at all times for signals, which, under the block system, are comparatively close together. Switching on the main track, especially by switch engines in busy yards, is one of the principal sources of accidents on a railroad, and the efficiency of any system of block signalling may be measured by its capability to prevent accidents from this source.

Economy and increased facility in the operation of the train service are ensured by the fact that irregular trains are prevented from doubling up and causing blockades at passing and other points where track room is limited. They also follow from the greater uniformity in the arriving of irregular trains at terminals, which distributes more evenly the yard work of handling cars and power, and thereby also reduces traffic expenses, as the yard work can then be done more economically than when there is a rush at one time and a standstill at another.

With the block system most of the irregular movements of trains can be directed without the use of special orders, and with greater promptness, each block being in charge of a man who is on the spot and is familiar with the situation, and

to whom the dispatcher can give many orders relative to the movements of trains at that point, which orders would otherwise have to be addressed to the conductors and engine-men. This particular advantage is, of course, not obtained by the use of the automatic block system.

"Absolute blocking" is the method of operation in which two trains are never allowed to be on a block section at the same time. In other words, one train must not be allowed to enter the block until the preceding train has passed on to the next block.

"Permissive blocking" is a so-called form of blocking in which a train is allowed to enter a block before the preceding train has passed out. It is not blocking in the strict sense of the term, and by its use the fundamental principle of blocking—the keeping of trains a certain distance apart—is destroyed. The "time-limit" system is usually operated in connection with it.

The running of trains under absolute blocking does not in any way dispense with other methods of protection, such as flagging, etc., which are laid down in the standard code or other train rules.

It must not be assumed, because only one train at a time is ordinarily allowed

in a block, that only one can enter, for circumstances may arise making it necessary to admit a second train, such as a wreck train or an engine sent to the assistance of the preceding train in case of an accident. This, however, is an exceptional condition which does not affect the principle of operation for the regular traffic or train service.

The following are the American Railway Association's definitions of interlocking and block signals, as revised by its Joint Committee, February 20 and 21, 1896.

Block.—A length of track of defined limits, the use of which by trains is controlled by block signals.

Block Station.—The office from which block signals are operated.

Block Signal.—A fixed signal controlling the use of a block.

Home Block Signal.—A fixed signal at the entrance of a block to control trains in entering and using said block.

Distant Block Signal.—A fixed signal of distinctive character used in connection with a home block signal to regulate the approach thereto.

Advance Block Signal.—A fixed signal placed in advance of a home block

signal to provide a supplemental block between the home block signal and the advance block signal.

Block System.—A series of consecutive blocks controlled by block signals.

Telegraph Block System.—One in which the signals are operated manually upon telegraphic information.

Controlled Manual Block System. — One in which the signals are operated manually, and by its construction requires the co-operation of the signal-men at both ends of the block to display a clear signal.

Automatic Block System.—One in which the signals are operated by electric, pneumatic or other agency, actuated by a train or by certain conditions affecting the use of a block.

CHAPTER III.

THE BLOCK SIGNAL.

In laying out a block signal system a careful study of the line should be made on the ground, with respect to the locating of the block stations, special attention being given to junctions and yards. By block station is meant the position of the home signal or the signal tower which marks the actual point of division between the blocks. It has no reference whatever to the railroad station. Under the automatic system the block station has no visible indication, being merely an insulated joint in the track at some little distance from the signal itself. The following considerations may be of assistance in selecting the best location for a signal, but any case may require a special arrangement, which can only be determined on the spot.

Signals should be located at the most prominent points in the neighborhood—

that is, the points first seen on approaching the block station. Economy in first cost should not interfere with placing them in the most conspicuous positions. They should be located sufficiently distant from crossings with other railroads and from junctions, sidings and cross-overs, to give trains ample room to stop between the signal and the dangerous point which it protects. They should be located at the right of the main track, as viewed from approaching trains. Their elevation above the track should not, if possible to avoid it, exceed thirty-five feet, nor in the case of main line signals, be less than fifteen feet. Signals that are very high are often enveloped in fog or snow or otherwise obscured when a lower signal could readily be seen.

The best position for a block station ought rarely to be neglected for the sake of locating at a traffic station. Better results are obtained by placing the block station *where it ought to be*, than by favoring a traffic point where only a short distance view of the signals can be had.

There should be block signals at all junctions, railroad crossings at grade, ends of yards, cross-overs, passing sidings and draw-bridges, so that the movements of trains at such points will be well protected. The handling of trains is expedited by

having the switches operated from the block stations or cabins by the signal-men. The cost of the appliances for doing this is but little greater than that of good switchstands, while the cost of maintenance is much less in the former case than in the latter. Even if the block system is not adopted for the government of the train service on the open line, it may be introduced to advantage at such isolated points of exceptional danger as those noted above.

The fixed out-door signals used in blocking consist of home signals, advance (or starting) signals, and distant signals. They are preferably of the semaphore type, but other forms are often used, especially in automatic blocking.

The semaphore signal was introduced on railroads about 1841, in England, by Mr. C. H. Gregory. Numerous other forms of fixed signals were used before its introduction and are still being used, but the semaphore is fast superseding all the others, and will undoubtedly become practically the only form in use. As applied to railway signalling it consists of a vertical post from 3 to 40 feet in height, carrying a movable arm pivoted near the top of the post. This arm is usually capable of being moved through an arc of about 70 degrees, but sometimes moves as much as 90 degrees.

SIGNALLING AND TRACK.

The semaphore is a signal of *position* only, in the case of home or advance signals, and of *position* and *shape* in the case of distant signals. At night, position is indicated by the color of a light placed above the semaphore arm and working in connection therewith.

A semaphore home or advance signal will have one of two positions—horizontal or inclined. The horizontal position signifies "danger," or "stop" (block not clear), and is indicated at night by a red light. The inclined position (about 70° below the horizon) signifies "safety," or "go ahead" (block clear), and is indicated at night by a white light.

A semaphore distant signal is distinguished by its forked outer end, and will have one of two positions—horizontal or inclined. The horizontal position signifies "caution," or "go under control," and is indicated at night by a green light. The inclined position (about 70° below the horizon) signifies "safety," and is indicated at night by a white light. It is merely, however, an indication of the position of the home signal, to facilitate the operation of a fast train service. Thus the horizontal position signifies that the home signal is at "danger," and the train must therefore go under caution and be ready to stop at the home signal if the latter has

not in the meantime been lowered to indicate "safety." On the other hand, the inclined position of the arm of the distant signal signifies that the arm of the home signal is also lowered. The distant signal is therefore only a preliminary signal to notify an engine-man of the condition of the block before he actually reaches that block, the block itself commencing at the home signal.

In automatic blocking the signals are, as a rule, either of the "banner" or of the "banjo," or disk type, except that in the electro-pneumatic system, signals of the semaphore type are used. The banner signal is usually circular, with slat openings to relieve it from wind pressure. It rotates a quarter-circle. In the Union system "danger" is indicated by day by a full face view of the banner, and "safety" by an edge view of the banner, or by a full view of a banner of a different form. At night the different views of the banner are indicated by different colors from a light surmounting the banner.

Signals of the disk pattern are enclosed in a case. This case has a white frosted glass in the back which is exposed through a glass covered front and forms the "clear" signal by day, when the disk is out of sight. When at "danger" the disk is displayed through the glass-covered front. In the Hall system the signals

are indicated at night by a light showing through a small opening in the front of the case just above the large opening. When the signal is at "danger" the small opening is covered by a red lens, which is actuated by the same mechanism that actuates the disk signal; when at "clear" the light is white.

The home signal is placed at the entrance to the block. At stations where there are cross-overs or sidings it should be so placed that trains can at all times run quite up to it without fouling any of the switches.

In locating the home signal on single track lines care must be taken that the blocks are not made to overlap. In other words, the home signal governing the entrance to a block for trains running in one direction must be so placed that a train can go to it without encroaching on the block for trains running in the opposite direction. This should be the arrangement of the home signals at every single track block station, whether there is a passing siding there or not. The rule that a train leaving a block station has a right to proceed quite up to the home signal of the block station in advance should always govern in the locating of home signals. Or, as a general proposition, it may be said of home signals for single track blocking, that they must be so located that two trains moving in opposite directions

toward a common point can be stopped at that point clear of each other, by those signals.

The advance signal is intended to hold a train which has been permitted to enter a short distance into a block already obstructed. It should be placed, when practicable, a maximum train length ahead of the home signal with which it operates. Generally speaking, an advance signal may be considered as dividing a block into two smaller blocks—one extending from the home signal to the advance signal, and the other from the advance signal to the home signal of the next block in advance.

Distant signals indicate the position of home signals. They should be placed, when practicable, not less than 2,000 feet (more if possible) in the rear of the home signals with which they operate.

While it is desirable to place the distant signal at least 2,000 feet from the home signal that it applies to, and the advance signal a maximum train length ahead of the home signal, this should not be done at the expense of having the distant and advance signals out of the signal-man's sight, except where absolutely necessary, as for instance, on heavy down-grades.

The normal position of block signals is "danger" ("caution" in the case of distant signals), except in "normal safety" automatic blocking. The signals are placed at "danger" immediately after the passage of a train, and in American practice are left so until permission is received from the block station in advance to let another train proceed under "safety," or as long as there is an obstruction of any kind in the block. In the "normal safety" automatic systems (with semaphore or disk signals), the signal for each block is cleared, or returns to "safety" as soon as the train has passed out of the block. In the "normal danger" automatic systems, the signal is only cleared in front of an approaching train (supposing the block to be unoccupied).

Trains may run up to, but not beyond, home or advance signals at "danger." They must not proceed until the clear signal or proper authority to pass the "danger" signal is given. When a distant signal is at "caution" trains may pass it under control, prepared to stop at the home signal. Home, advance and distant signals at "safety" may be passed without reducing schedule speed.

A train that is to be held at an advance signal must first be brought to a stop

at the home signal. It may then be allowed to proceed, under control, to the advance signal. The clearing of a home signal, in any case, gives authority to proceed to the advance signal only. To avoid the necessity of placing the home signal at "clear" for a train that is to be held at the advance signal, an auxiliary signal may be used. This is known as a "calling on" signal, and is a short semaphore blade fixed upon the home signal post below the home signal blade. When in the "safety" position this signal gives a train authority to pass the home signal at "danger" and proceed under control to the advance signal.

Except in automatic blocking the signals are operated from the towers by means of levers resembling the reverse lever of a locomotive which are connected with the signals by wires or pipe. If wire is used there should be two lines for each signal, one for pulling it to "danger," and the other for pulling it to "safety." To ensure the signal being set at "danger" in the event of the breakage of the wires the blade should be provided with a counterweight.

Usually there is a lever for each signal, but in some instances, as at an interlocked point, one lever may be used to operate several signals, by means of a device

known as a "selector." The selector connects the signal lever with a particular signal of a series, the one so connected depending upon the position of the switch and the movement governed by the signal.

The levers must be so interlocked that the home and advance signals require to be placed at "clear" before the distant signal can be so placed. This interlocking is accomplished by means of locking bars attached to and operated by the signal levers. The locking machine consists of a frame carrying the necessary locking bars, placed in front of or below the levers.

Signal wires that are over 1,000 feet in length are often provided with some device for automatically adjusting the effects of expansion and contraction due to changes in temperature, and the stretching of the wire caused by wear.

The blades and lights of all the signals should be visible from the tower. Where the front lights cannot be seen, the lamps should be fitted with back lights, the latter being as small as practicable, having regard to efficiency. Where the front lights can be seen from the tower, back-lights should not be provided. If a signal is so situated as to be out of the view of the signal-man, a "signal repeater" and a "light commutator" working in connection with the signal, may be placed in the

tower to indicate respectively the position of the signal, and whether the light is "in" or "out." The signal repeater is an electrically operated instrument having a miniature signal arm, and when the outdoor signal is lowered this miniature arm is at an angle of 45° below the horizontal, the armature then assuming a vertical position by gravity. When the outdoor or line signal is set at "danger" the action of a commutator fixed on the line signal-arm forms a circuit which causes the miniature arm to assume a horizontal position.

Separate signals are provided for trains in each direction. Where semaphore arms governing trains in opposite directions are mounted on the same post, the one on the right hand side of the post as viewed from an approaching train governs that train.

Each track must have its own block signals. Where trains proceed in the same direction on different tracks, the signals relating to these tracks are generally placed on the same post, or, as shown on page 170, on a bridge spanning the tracks. In the former case the post supports a cantilever bracket carrying short posts upon which are mounted the signals, the post carrying the main track signal being higher than the others, and nearest the main track. An arrangement of signals for trains

in the same direction on different tracks that is simpler, is to have the signal governing the main track movement on a high post by itself and all others on low posts. As all movements from and on side tracks are made at comparatively slow speed, the position of low signals may be readily observed by those interested. Then only the signals governing the through main track movement will be conspicuously visible from a train approaching on the main track. This method of signalling is especially convenient for high speed movements, as where there is but one set of conspicuous signals, and that governing the through or high speed movement only, there is no reason for doubt in the mind of the engine-man of an approaching through train as to which signals govern him.

Where blocks are short, as in yards, it may be necessary to place the distant signal of a station on the post of the home or advance signal of the station in the rear. When a distant signal so placed is at "caution" the signal-man at the rear station must keep his distant, home and advance signals (or such as are provided) against any approaching train until the train is brought to a stop. If there is no obstruction at his station, and he has received "block clear" from the station in advance, he may then lower his signals for the train to go forward, but this does not

relieve the engine-man from keeping the train under control in approaching the home signal of the block ahead.

As the color of the blade has nothing to do with semaphore signal indication —position and shape of blade only governing in this matter—the color best adapted to local conditions may be used. On many lines home and advance signal blades are painted red, with a broad white stripe across near the outer end, and distant signals are painted green with a similar white stripe. On other lines orange has been adopted as the color for distant signals. Local characteristics, such as the color of the background and atmospheric conditions may be allowed to govern, although for many reasons a uniform standard is desirable.

The selection of any particular colors for signal lights, as white for "safety" or "go ahead," and red for "danger" or "stop," is somewhat arbitrary. Any colors may, with propriety, be used. In fact, on some of the leading English lines, green has recently been adopted as a "safety" signal, the use of red as a "danger" signal being continued. Green, instead of white, is used for "safety" to prevent the mistaking of a white light in the neighborhood of a block signal for a "clear" signal, in the event of the signal light being out; another purpose is to prevent the

signal light from showing clear, when the reverse is intended, in the case of the glass lens being broken.

On American lines white is commonly used to denote "safety," "go ahead;" red, "danger," "stop;" and green "go ahead cautiously to the next signal." The Joint Committee on Interlocking and Block Signals, of the American Railway Association submitted this, at the meeting of the Association, in April, 1895, as the Committee's recommendation relative to the colors of night signals:

"The Committee does not at this time deem it wise to recommend abandoning 'white' for a night signal,—as,—first, three indications are necessary in many cases, and second, no entirely satisfactory single color has been found for a third indication. The Committee approves, however, the use of 'red' for 'danger,' 'stop;' and 'green' for 'clear,' 'proceed'; as good signal practice."

An electric slot, or reverser, for automatically returning the home and advance signals to "danger" after a train has passed them, is of great advantage in the manual system, as by it a train protects itself effectually against following trains. This apparatus is actuated by a track circuit, as described on page 165.

Another useful appliance is the "mechanical slot," a device by which a

distant signal is put under the control of the signal-men at any number of nearby points—often a desirable feature. This device avoids the necessity of a multiplication of distant signals. With it the consent of all the signal-men concerned is required to place the signal at "clear," although any one of them can place it at "danger."

CHAPTER IV.

THE SIGNAL LAMPS.

Signal lamps should give sufficient divergence of the rays for the light to show clearly around an open curve, if located thereat. Good drainage and good ventilation must be provided for in the lamps, and since much depends upon the proper working of these lamps, every care must be taken to keep them in good condition. The greatest trouble arises from failure to clean the lamp cups well and to properly adjust the flame at the start. It is of the utmost importance to have a low flame at first, as this prevents the overflowing of the oil from the wick feeding too freely. Overflowing oil is apt to take fire and destroy the lamp. If the flame is too high, the lamp will smoke badly, thus choking the ventilator holes. If the flame is too low, the wick is apt to become crusted, which prevents free burning and keeps the

heat below the crust. As a consequence the thin brass of the burner becomes so hot as to generate a gas in the lamp cup, often causing an explosion. The following are some of the points that should be observed in the care of a lamp:

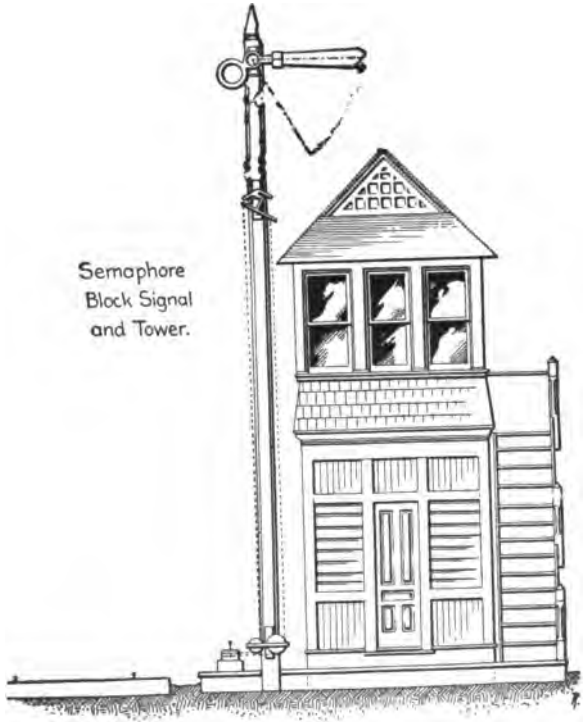
1. Fill the oil cup, trim the wick and clean the lamp daily.
2. The wick should fit neatly in the burner.
3. The wick may be best trimmed by carefully scraping off the burnt portion. It should not be trimmed by cutting.
4. When the wick becomes gummy or obstructed and does not draw oil freely, reverse the wick end for end.
5. Be careful to have a low flame at first, and to regulate it carefully about ten minutes after lighting.
6. If the burner gives a ragged flame it probably needs cleaning. If cleaning does not correct the trouble a new burner should be put in.
7. When the lamp is not lighted, turn the wick down so that its top is in the tube, to prevent overflowing of oil.
8. In cleaning the lamp, remove the cap at the top, and clean out all soot which may have collected in the ventilator, but be sure to replace the cap.

9. Keep the lenses perfectly clean inside and out. If the smoke and dirt cannot be removed from them otherwise, use sand and water.

10. Before lighting be careful to wipe off all oil from the inside of the lamp, especially from the cup.

Electric light, where available, gives the best satisfaction in signalling, and these lamps, being free from grease, smoke, etc., require much less attention than others. The Pintsch gas system could be used to advantage where there are a number of signals in one neighborhood, as in yards and at interlocked points.

The "light commutator" is an instrument to be attached to the signal lamp and connected by an electric circuit with a repeating instrument in the tower, and its use is desirable if the light is so situated that it cannot be seen from the tower. The contraction of certain metal rods in the "light" instrument, caused by the reduction of temperature when the light goes out, breaks the circuit, releasing the armature of the magnet in the tower instrument. This causes a bell to ring, and also gives visual notice by showing the word "out" on the indicator of the tower instrument.



Semaphore
Block Signal
and Tower.

CHAPTER V.

THE BLOCK TOWER.

The block tower, used only in systems of blocking requiring men to operate the signals, is generally a two-story building, with the office located in the second story, so as to secure from it a good view of the line and of passing trains. The tower is of a size depending on the number of signal levers at the station. A good view for the signal-man is essential, it often being necessary for him to note the movements of two trains passing the block station at the same time.

The batteries for working the bell wire and for working the ordinary telegraph wire should be kept in the tower where they will not freeze. The battery boxes may be located on the lower floor where they can be attended to and cleaned without littering the office.

Following are the Western Union Telegraph Co.'s instructions relative to attaching office wires:

"Cross arm fixtures should be attached to office buildings with bolts passing through the wall instead of door or window casing wherever it is practicable to fasten them in this way. Screws should never be used for fastening fixtures to buildings, as they are liable to pull out when subjected to a heavy strain.

"The full sized line wires should be carried to the inside of the building from the standard glass and pin insulators on a cross arm attached to the wall with iron fixtures in such a manner that the wires will have an upward direction from the insulators to the point where they enter the building, to prevent rain and moisture from following them to the wall. Where the wires run into the building in exposed places, they should be covered with a sloping roof board of sufficient width to perfectly protect them from rain and snow, and should be insulated with rubber tubing where they pass through walls and partitions, using tubing of sufficient length to go entirely through the wall from outside to inside of the building.

"Where telegraph offices are located in railway stations or similar long buildings, the wires should enter such offices at the window or other opening nearest

the switchboard, and should be so strung that they can be plainly seen and easily inspected at all times.

"At railroad crossings all wires must be kept at a height of not less than twenty-five feet above the rails and at public and private highway crossings not less than eighteen feet above the roadway.

"Porcelain insulators and knobs must not be used outside of buildings. Rubber hook insulators must not be used outside of buildings, except in places where they are completely protected from rain, snow or moisture and where it is impracticable to use the standard glass insulation.

"In the construction, reconstruction and general repairs of lines, all splices must be soldered.

"All connections between copper and iron wires must be soldered.

"The wires inside of a building should be insulated on wooden cleats, and kept as far apart and as far from the ground as possible. The use of staples for attaching office wires is forbidden.

"All connections in main battery wires must be soldered and the wires insulated.

"Permanent terminal ground wires should be composed of Number 8 copper wire, and they should be soldered to the main gas or water pipes, where practicable."

The windows in front of the lamps of the tower should be screened to prevent the lights from being mistaken for signals. The station number or call should be painted on the front and sides of the building, and may also be cut on a window glass on each side of the tower, so as to be conspicuous to approaching trains.

The stove, on account of its dust and dirt, should be located on the ground floor, and the office heated by a register or drum. The drum will perhaps give the better result.

CHAPTER VI.

SIGNAL BELLS.

In manual and controlled blocking the signalling of block stations with each other is usually done through electric bells. The bells governing each block are connected by a separate wire, thus:

A B C D E F

The bell apparatus of a block station consists of a battery, and, for each block, an electric bell of distinctive tone and a double-point strap-key for working the bell at the opposite end of the block. The Leclanche battery, if properly constructed, gives excellent satisfaction in bell signalling. It is easy to maintain, usually lasting without attention for nine months. The single stroke bell gives the best results in code signalling. Vibratory bells may be used, but they are not

so satisfactory, the tendency of signal-men being to work the bells rapidly, which causes the strokes of the vibratory bells to run together and be unintelligible.

The bells should not be used for other purposes than signalling trains, except when they are used by inspectors or linemen in making tests or repairs. A code for carrying on private conversation might be misunderstood and lead to an error in train signalling.

The general causes of failures of electric bells are imperfect contact, faulty adjustment, and defective insulation. Wooden bases for bells may also cause trouble, by warping. The magnets, armatures and other working parts should be covered to protect them from dust, dampness, etc., and care taken to keep *all* parts free from dust, dirt, grease and rust.

The bells should not be worked too quickly, but each movement of the key should be made sharply and distinctly, so as to give a clear and distinct stroke on the bell for each touch on the key.

Good wiring is essential to perfect working of the bells. The bell hammer must also be adjusted to move within a carefully defined space, as slight variations are apt to cause an unsatisfactory action of the hammer.

CHAPTER VII.

THE BLOCK RECORD.

The prompt handling of trains, in manual and controlled blocking, depends largely upon keeping a complete "block record" of the bell signals for each train movement. To this end the record should show the time "block clear" was given, the train number (or at least the engine number of the train), the time the train was rung in from the rear block station, the time the train arrived at the block station keeping the record, the time of departure and when "train clear" was given to the block station in the rear, and the time "train clear" was given by the station in advance. In single track blocking the record should show the time each bell signal relative to "head-to-head" movements was received. Under "remarks" should be noted the number of each train taking a siding or back-

ing over on to the opposite track, with the time the train took the siding or opposite track, and the time it returned to its own track. Any information relating to accidents to trains, obstructions in the block, unusual work done by track men, and the times at which the lamps were lighted and extinguished should be noted. In fact, the record should contain an outline history of the day's work at the station. Obviously that part of the record relating to the movement of trains is the most important, and signal-men must make those entries at once. Each signalman when going off duty should sign his name on the block record, and enter upon the record the time during which he was on duty. The block record should begin at midnight, a separate page or sheet being used for each day's business. All block records should be sent to the superintendent's office for filing.

The following is a copy of the form of block record used on the Erie Railroad :

ERIE RAILROAD CO.

BLOCK RECORD.

Operat's on Duty { ——— M. to ——— M. / ——— M. to ——— M. / ——— M. to ——— M. } Signal Office, ——— 189

EASTWARD.						WESTWARD.					
TRAIN	RUNG IN FROM	ARRIVED	DEPARTED AND CLEAR GIVEN	CLEAR FROM	REMARKS	TRAIN	RUNG IN FROM	ARRIVED	DEPARTED AND CLEAR GIVEN	CLEAR FROM	REMARKS

NOTE.—These records must be kept complete and filed away each day for reference. Use Ink.

CHAPTER VIII.

TRAIN ORDERS AT BLOCK STATIONS.

Rule 524 (B) of the standard code of train rules, American Railway Associaton, says in substance: *While a red train order signal is displayed, all trains must come to a full stop, and any train thus stopped may pass the red signal after receiving an order addressed to such train, or a clearance card on a specified form stating over the operator's signature that he has no orders for it.* When block signals are in use, this rule must *not* be construed as giving a train authority to pass a block signal, even after the train has received train orders or a train-order clearance card.

When it is necessary to place a train order at a block station, in the absence of a fixed train order signal a red flag by day and a red light by night, indicating "train order," must be displayed from the side of the block station facing the train

for which the order is held. After the order has been delivered, the signal-man and those in charge of the train must be governed wholly by the block rules in having the train go forward. If a train arrives at the block station ahead of the train for which orders are held, to the train ahead must be given a written notice in the form of a train order clearance card, that the train order signal is displayed for a specified following train. This notice pertains only to the train order signal and gives no authority whatever to pass the block signal, which may only be passed as provided in the block rules. During the time a train order is held at a block station the block signal must be kept at "danger," except to allow a train to pass according to block rules, when such train has received authority to pass the train order signal.

CHAPTER IX.

BLOCKING AT RAILROAD CROSSINGS AND JUNCTIONS.

The principle of absolute blocking at junctions, or at crossings at grade is that all the blocks intersecting at a junction or crossing frog shall be operated as one block.

At a single track junction or crossing, when a train is approaching from any direction, or fouling the frog, all other approaching trains must be held back until this train has cleared the frog.

At a double track junction or crossing, when a train is approaching, or is fouling the frog, other trains must not be allowed to approach the junction or crossing (except on the parallel track of the same line), until this train has cleared the frog.

Junctions and crossings should be provided with the regular block signals,

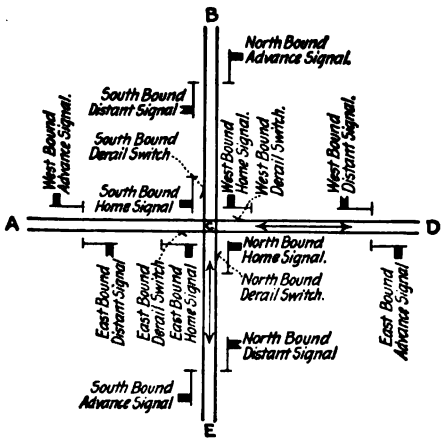
and also with interlocked switch signals, and with derail switches. The latter are opened when the signals with which they are connected are set at "danger," so that a train running past a signal at "danger" will be turned off the track before it can meet a train on another track at the fouling point. Where the track is level the derail switch should be placed not less than 500 feet from the fouling point. On a grade descending toward the junction or crossing, the derail should be placed far enough away to give the same degree of safety that it would on a level track at a distance of 500 feet. The block signals, switches and switch-signals should be so interlocked that a clear block signal cannot be given when there is an intervening switch set for a different movement. In other words, the switches must be set to give a clear route or track before the signal can be set to indicate "safety" for that route.

At railroad crossings and junctions distant signals should be provided, placed when possible not less than 2000 feet from the fouling point, and on descending grades, placed far enough away to give the same degree of safety that they would give on the level at a distance of 2000 feet.

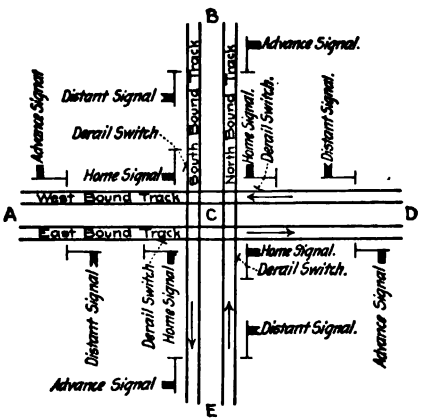
The rules for operating the block system are the same at railroad crossings

and junctions as at other points. In addition to the block rules, special instructions in regard to the interlocking switch signals, and covering local conditions, should be issued for each interlocked station. These instructions should include the location and use of each signal and derail switch, and, where more than one signal blade is displayed from a post, the instructions should state, specifically, the route each blade refers to. Signals controlling "back up" movements—or movements opposite to the current of traffic on main tracks—should be clearly described, and the movements as well as the territory controlled by each signal should be stated.

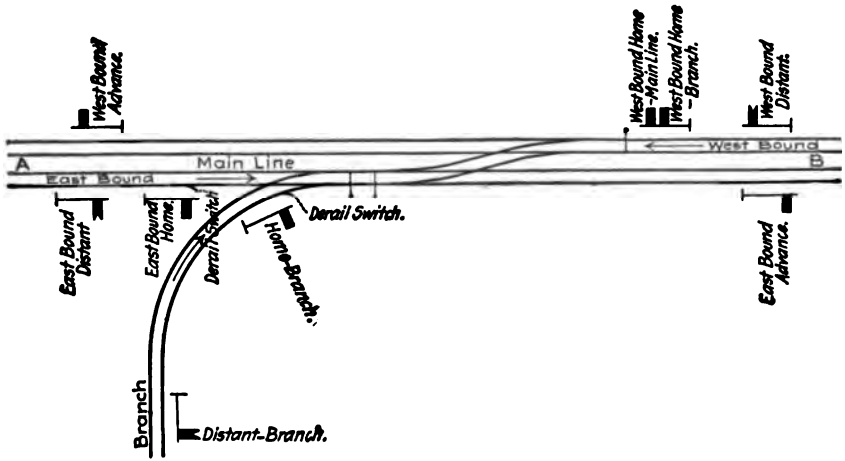
The following diagrams show some of the principal arrangements of block signals at railroad crossings and junctions:



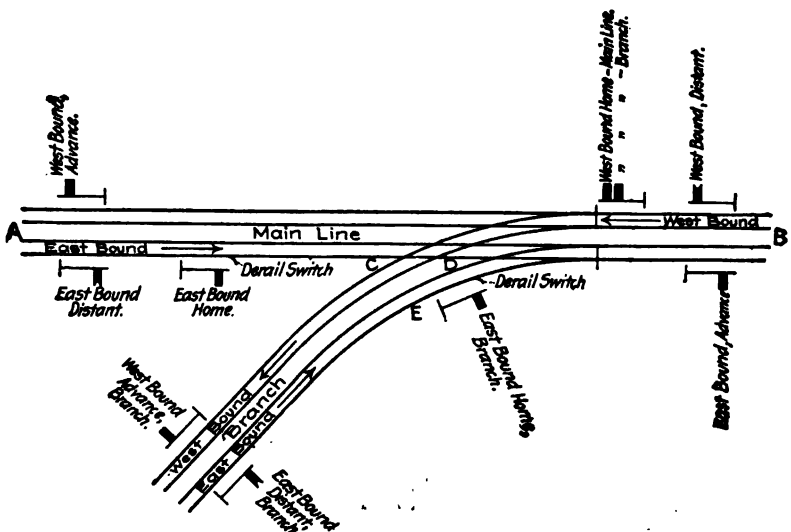
BLOCKING AT A SINGLE TRACK RAILROAD CROSSING.



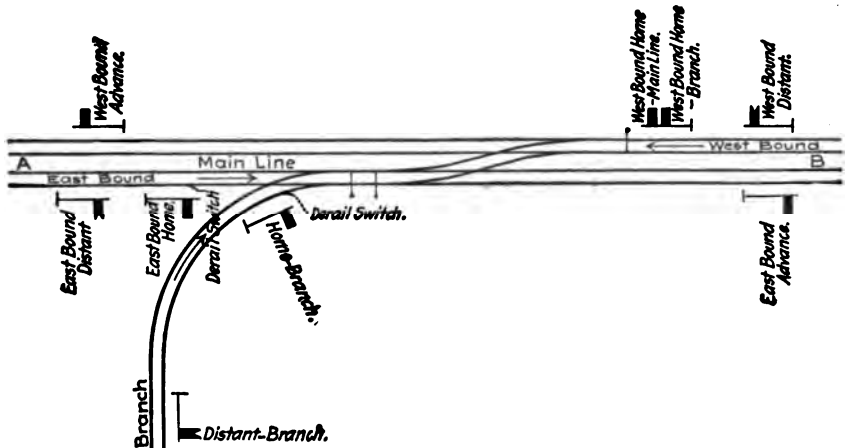
BLOCKING AT A DOUBLE TRACK RAILROAD CROSSING.



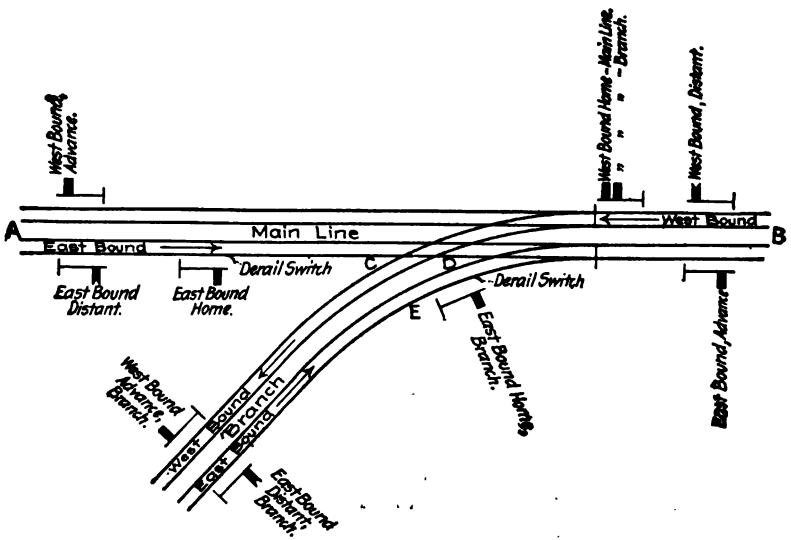
BLOCKING AT A SINGLE AND DOUBLE TRACK JUNCTION.



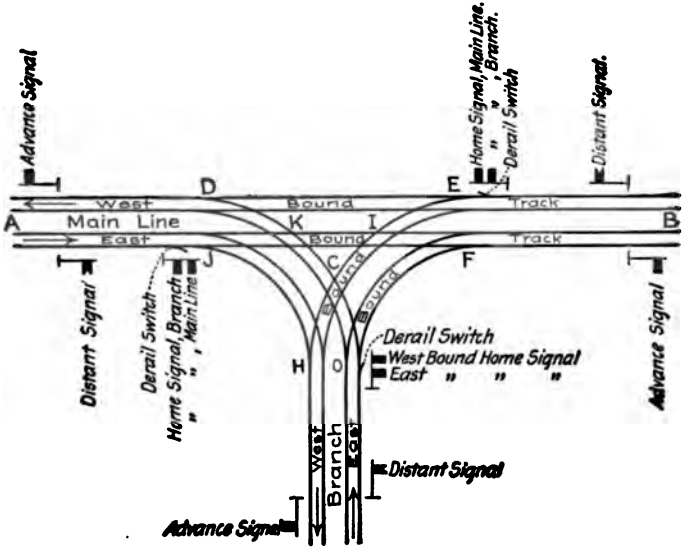
BLOCKING AT A DOUBLE TRACK JUNCTION.



BLOCKING AT A SINGLE AND DOUBLE TRACK JUNCTION.



BLOCKING AT A DOUBLE TRACK JUNCTION.



BLOCKING AT A DOUBLE TRACK TRIANGULAR JUNCTION.

Only movements *with* the current of traffic—that is, movements in the right direction—have been considered. Movements in the reverse direction of traffic (or "backing-up" movements) are sometimes necessary and these must be guarded in the same manner, but by separate signals provided for the purpose.

The apparatus used at railroad crossings and junctions to ensure the proper display of the switch signals when the switches are changed from one position to another—that is, set for a different route—and to operate the switches and signals from a central point, is known as an interlocking machine. The fundamental principle of the design of the interlocking machine is that when the switches and signals are set for any one route, no switch or signal can be set for any conflicting route, or a route which would foul the route already "cleared." In this way collisions at junctions and switches are effectually prevented. The interlocking signals are not a part of the block system proper, but, as already stated, they should be arranged to work in connection therewith.

The necessity of having the switches and signals co-operate in order to prevent such accidents as are apt to occur from the independent working of the switches from several points, was early experienced by the railroads, switches being fre-

quently set for one move and signals for another, causing innumerable accidents. The first practical interlocking machine was invented in 1856 by Mr. John Saxby, an English signal engineer.

From a carefully prepared paper on "Railroad Signals and Signalling," read before the New England Railroad Club by Mr. R. H. Soule, now Superintendent of Motive Power of the Norfolk & Western Railroad, the following is taken:

"A lever which is to lock certain levers and release certain other levers must complete all its locking functions before the beginning of its stroke, and must not accomplish its releasing or interlocking functions until after its stroke is completed.*

"The spring-catch affords the means by which it is possible to meet these conditions; and it is now invariably used to actuate the interlocking mechanism. The result is that the interlocking mechanism receives an initial movement prior to the stroke of the lever, is maintained in a state of rest during the stroke of the lever, and receives a final movement after the stroke of the lever is completed. These features of interlocking are common to all successful machines, although the means by which they are accomplished may differ." The spring catch is the small handle

* This is the principle of preliminary locking.

set at the side of the handle of the switch or signal lever, and is connected to a lug or stop which drops into a slot in the sector bar of the lever frame when the lever is at either end of this stroke, thus holding the lever in position. The signal-man grasps the lever handle and spring catch at the same time, but must grip them so as to bring the latter close against the former, and this movement raises the lug or stop, so that the lever can then be moved to the other end of the sector, when by releasing his grasp on the handle the spring catch forces the clasp down into the other notch. It is this movement preliminary to the stroke of the main lever which is used to actuate the interlocking mechanism, and thus no strain can be put on this mechanism by an attempt to throw a wrong lever, since the lever must be unlocked by its spring catch before it is free to move.

The following interlocking principles were given by Mr. Soule:

"1. Each home signal lever, in that position which corresponds to the clear signal, must lock the operating levers of all switches and switch locks which by being moved during the passage of a train, running according to that signal, might either: *a*, throw it from the track; *b*, divert it from its

intended course; or *c*, allow another train (moving in either direction) to come into collision with it.

"2. Each lever so locked must, in one of its two positions, lock the original home signal in its danger position; that position of lever being taken which gives a position of switch, or switch lock, contradictory to the route implied by the home signal when clear."

"3. Each home signal should be so interlocked with the lever of its distant signal that it will be impossible to clear the distant signal until the home signal is cleared.

"4. Switch and lock levers should be so interlocked that crossings of continuous tracks cannot occur, where such crossings are dependent upon the mutual position of switches.

"5. Switch levers and their lock levers should be so interlocked that the lever operating a switch cannot be moved while that switch is locked."

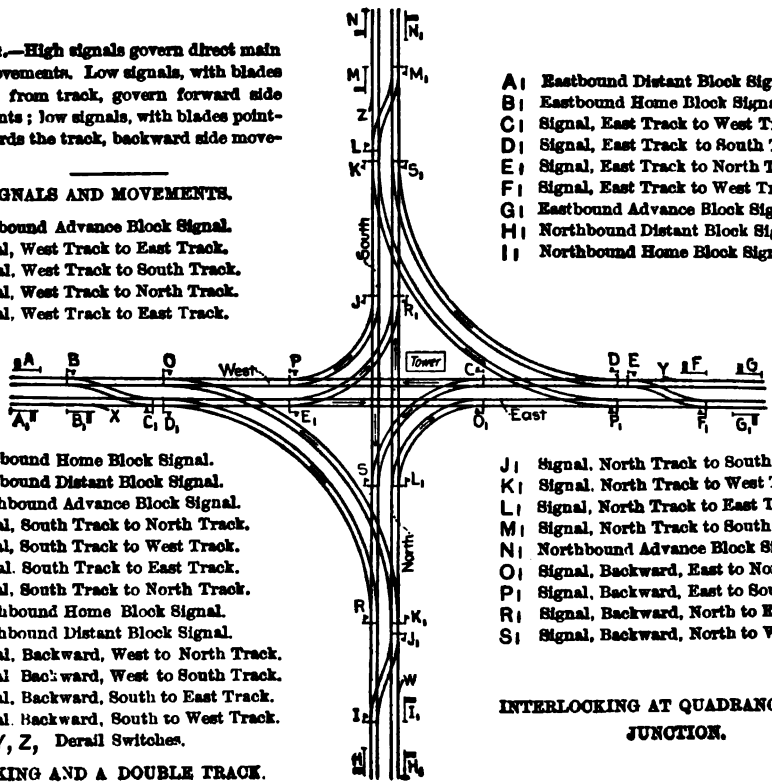
The accompanying diagram shows the arrangement of signals for blocking and interlocking at a double-track quadrangular junction.

The following is taken from the Illinois Railroad and Warehouse Commis-

NOTE.—High signals govern direct main track movements. Low signals, with blades pointing from track, govern forward side movements; low signals, with blades pointing towards the track, backward side movements.

SIGNALS AND MOVEMENTS.

A Westbound Advance Block Signal.
B Signal, West Track to East Track.
C Signal, West Track to South Track.
D Signal, West Track to North Track.
E Signal, West Track to East Track.



F Westbound Home Block Signal.
G Westbound Distant Block Signal.
H Southbound Advance Block Signal.
I Signal, South Track to North Track.
J Signal, South Track to West Track.
K Signal. South Track to East Track.
L Signal, South Track to North Track.
M Southbound Home Block Signal.
N Southbound Distant Block Signal.
O Signal, Backward, West to North Track.
P Signal Backward, West to South Track.
R Signal, Backward, South to East Track.
S Signal. Backward, South to West Track.
W, X, Y, Z, Derail Switches.

BLOCKING AND A DOUBLE TRACK.

A Eastbound Distant Block Signal.
B Eastbound Home Block Signal.
C Signal, East Track to West Track.
D Signal, East Track to South Track.
E Signal, East Track to North Track.
F Signal, East Track to West Track.
G Eastbound Advance Block Signal.
H Northbound Distant Block Signal.
I Northbound Home Block Signal.

J Signal, North Track to South Track.
K Signal. North Track to West Track.
L Signal, North Track to East Track.
M Signal, North Track to South Track.
N Northbound Advance Block Signal.
O Signal, Backward, East to North Track.
P Signal, Backward, East to South Track.
R Signal, Backward, North to East Track.
S Signal, Backward, North to West Track.

INTERLOCKING AT QUADRANGULAR JUNCTION.

sion's latest rules governing the construction of interlocking devices in the State of Illinois:

"It being desirable that a uniform system of signals should be used at all interlocking plants, it is recommended that all signals should be of the semaphore type. All signals must be so constructed as to go to the danger position by force of gravitation in case of the breakage of connections between the operating lever and the signal. All signals must be provided with a lamp showing front lens properly focused and a back light, except as hereinafter provided.

"The home signal should, when practicable, be located on engine-man's side of track it governs, and should be not less than fifty (50) feet nor more than two hundred (200) feet in advance of the point it governs, except where special conditions exist. The signal must point to the right of the track it governs, and should have a square end. When the derail or facing point or crossing is set against the traffic governed by the home signal, the signal must be locked in a horizontal position, showing red or 'danger' color light by night, indicating 'danger—stop.' When the track it governs is clear and safe for the passage

of trains the signal may be inclined at an angle of about sixty (60) degrees or more from the horizontal, showing a white or 'line clear' light by night to approaching train, indicating 'clear track—advance.' In case two signal arms are used on the home signal post, the top signal should in all cases govern main or high speed routes, and the lower signal the diverging route or routes. In mechanical interlocking plants the home signal may be worked by either pipe or wire connections. In case wire is used there must be two lines.

"The distant signal should be located not less than twelve hundred (1,200) feet in advance of the home signal with which it operates, on the same side or track, with the arm pointing in the same direction. The distant signal should be distinguished by a notch cut in the end of the semaphore arm. It must be so arranged and connected with the home signal that it will be held in a horizontal position, showing green or 'caution' color light by night to approaching train when the home signal indicates 'danger.' The distant signal must be worked by two lines of wire.

"Rotating indicators, known as pot or disk signals, should only be used as switch indicators, operating with the switch.

"A dwarf signal having a small arm, and suitably adapted as to height, should be similar in design and location to the home signal. It should be used only to govern movements on secondary tracks or movements against the current of traffic on main tracks when such reverse movement becomes necessary, and where necessary in yards.

"Bracket posts should be used in all cases where it is necessary to signal trains on different tracks, operated in the same direction, from the same main post; the position of the post on the bracket to correspond to the position of the tracks on which movements are to be governed.

"The signal-man in the tower should be able to see the arms or the back lights of all signals; the back lights of the lamps to be made as small as practicable, having regard to efficiency. When the front signals are visible to the signal-man in the tower, no back lights should be provided. If from any unavoidable cause the arm or light of any signal cannot be seen by the signal-man, a repeater or indicator should be provided in the signal tower.

"The fixed lights in the signal tower should be screened off so as not to be mistaken for the signals exhibited to control the running of trains.

"Where the grade is level the derail point on high speed main route track should be located, when practicable, three hundred (300) feet in advance of the fouling point which it protects. In case of a descending grade toward the crossing, the derail point should be located so as to give the same measure of safety equal to three hundred (300) feet in advance of fouling point on high speed tracks having level grade. Where a single main high speed track of one railroad crosses another railroad at the same level, and traffic is carried in both directions on each track, then derails should be provided on each side of the crossing in the manner hereinbefore described for high speed main tracks. Guard rails may be required.

"On secondary tracks, such as switching, drilling, storage and low speed tracks, the position of derail point should be located so as to give the same measure of safety indicated for high speed tracks.

"When a crossing is made by a switching, drilling, storage, or low speed track with a high speed track moving traffic in either direction, the derails on high speed tracks should be located on each side of the crossing in the manner first described.

A derail should be located on the secondary tracks on each side of the crossing in the manner described hereinbefore for switching, drilling, storage or low speed tracks.

"In case one or more secondary low speed tracks cross each other at grade, each track should be provided with a derail on each side of the crossing. The distance of derail in advance of crossing should be governed by the character of traffic upon such tracks, provided that the same measure of safety is applied to such crossings as is required for the protection at crossings of high speed tracks.

"In case a spur, siding or switch connects with the main track, between the derail and the crossing which it protects, the spur or siding should be treated as the crossing track, and be provided with a derail in accordance with the foregoing regulations.

"In case of double-track crossings where the current of traffic on each track is, as a rule, in one direction, a derail should be provided for back-up movements, and for the further purpose of ensuring clearance of crossing before clearance signal can be given on the opposing route. The derail should be placed not nearer than one hundred and fifty (150) feet nor more than three hundred (300) feet from the crossing.

"In mechanical interlocking plants all derails and point switches, whether facing or trailing, must be worked either by iron or steel pipe not less than one inch in diameter or by an iron or steel rod.

"All slip switches, movable point frogs and derails should be locked either by a separate line of connections from those used to move such slip switches, movable point frogs or derails, or by a double pointed switch and lock movement of approved pattern. Where the double pointed switch and lock movement is used on main tracks, it should be in connection with a bolt lock operated in connection with home signals.

"Switch movements should be located on long ties extending a sufficient distance from the rail or on other suitable foundation, and the switch movement should be further connected with the rails by a continuous plate extending under the rails, fitted with rail braces to ensure accurate adjustment and maintenance of gauge of track.

"All derails and facing point switches should be protected by detector bars. The detector bars must exceed the greatest distance between the adjacent wheels of the longest car, and in no case should they be less than forty-five (45) feet in

length. The first interval of the movement of switch lever which withdraws the locking pin must at the same time raise the detector bar above the level of the rail. The final movement of the switch lever must return the detector bar to its normal position—level with the rail. If the detector bar is not worked by the switch lever, it must be actuated before the switch is moved in either direction.

"When a crossing is used for drilling with short trains, or where trains make a station stop on or fouling the crossing, a detector bar may be required at the crossing. In such cases the bar should be interlocked with the movement that operates the derails, to ensure a clear crossing before an opposing route can be set or signal be given.

"In all mechanical interlocking, the levers by which points and signals are worked should be grouped in a tower and supported on a suitable foundation, which should be independent of the foundation of the tower. All levers should be pivoted on one common center, and so arranged as to bring the switch levers and locking levers in the center of the frame. The levers operating home signals should be placed next to levers operating switches and locks, and the levers operating distant signals should be placed on the extremities of the frame following the

home signal levers. The levers should be numbered from left to right. The visible parts of the levers above the machine, except the finished part of the handle should be painted as follows: Switch levers, black; lock levers, blue; switch and lock levers, black and blue; home signal levers, red; distant signal levers, green; and movable frog point levers, black or yellow.

"The locking should be actuated by the action of the latch rod, or by a device performing similar service in advance of the first movement of any lever. The first act in reversing a lever must lock the levers of all conflicting routes.

"The levers should be so arranged that while the signals are in their normal position, *i. e.*, at danger, the levers operating points shall be free to move: *provided, however*, that the preliminary act for reversing any lever shall lock all signal levers controlling opposing routes. The arrangement of locking must be such as to make it impossible for the signal-man to lower the signal for the approach of a train until he has first set the points in the proper position for it to pass over the route governed by such signals. The locking must be so devised as to make it impossible for the signal-man to exhibit at the same moment any two signals or combination of signals that can lead to a collision.

"Signal towers should be so placed and of such height as to afford the best possible view of the functions of the interlocking plant.

"Each line of pipe operating points or signals must be automatically compensated. Such automatic compensators must be located at such intervals in the line as to completely provide for expansion and contraction at various temperatures.

"All pipe compensators and cranks must be fixed on suitable foundations.

"In case there are cross-overs, turn-outs or other connecting tracks involved in the general system, the movements of cars and trains upon which present an element of danger, which danger will be enhanced by the passage of trains over crossings or junctions without stopping, and consequently at higher speed than would be the case without the permit sought, then, and in all such cases, whether such enhanced danger be of collision between different cars or trains of the same road, or between cars or trains of different roads, it will be necessary, in addition to the protection of the main crossing, to provide by the proper devices and appliances against any such increased collateral dangers in the same complete manner that is required in the case of the main crossing.

"The material and workmanship must be, in all respects, first-class, and the

entire plant must be constructed in accordance with the best practice in signalling, and the plant, as a whole, must, when finished, be complete and perfect, and in every way fit for the purpose of its construction."

Following are some of the more important examples in the operation of signals for blocking at railroad crossings and junctions.

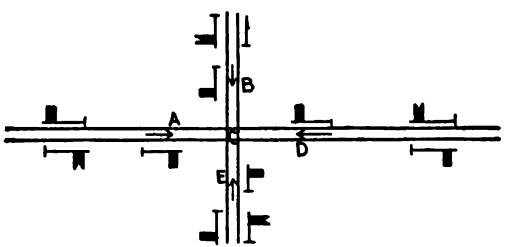


DIAGRAM A. SINGLE TRACK CROSSING.

In Diagram A, when there is a train at C all trains approaching that point must be held at A, B, D and E.

In the double track crossing, Diagram B, when there is a train at C all trains approaching that point must be held at A, B, D and E, except trains moving on the track parallel to the one occupied.

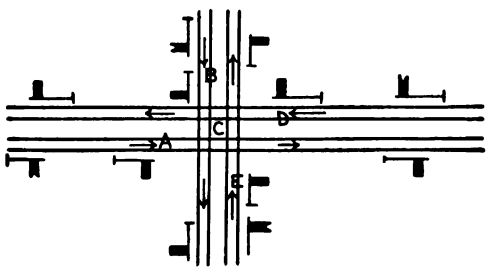


DIAGRAM B. DOUBLE TRACK CROSSING.

In the double track junction, Diagram C, an east bound main line train from A will foul at C a train crossing from the west bound main line to the west bound

branch line, and will foul at D a train going from the east bound branch line to the main line. Therefore, before the east bound train leaves A the west bound train for the branch should be held at B, and the east bound branch train for the main line at E.

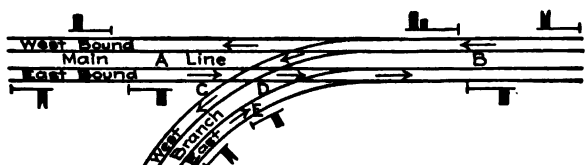


DIAGRAM C. DOUBLE TRACK JUNCTION.

In the operation of the junction of a single and double track, as shown on Diagram D, an east bound train from A to B would not come in contact with the forward junction movement.

An east bound train going from A, on the main line, to F, on the branch line, would foul the opposite movement from F to the west bound main line and the

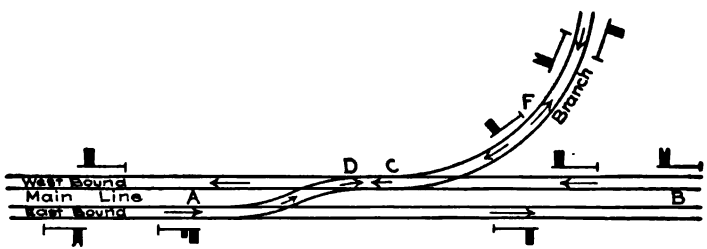


DIAGRAM D. JUNCTION OF A SINGLE AND DOUBLE TRACK.

main line movement from B to A. Therefore a train must not leave F or B after a train has been permitted to leave A for the branch line.

A west bound train from B to A would come in contact with the movement from the east bound main line to the branch, and with the movement from the

branch to the west bound main line. Therefore, when a west bound train leaves B for A, a train must not be permitted to leave A for the branch, nor a train to leave the branch for the main line.

A train from the branch would foul the movement from B to A, and from A to F. Therefore, a train must not be allowed to leave B, nor A when bound for F, after a train has been permitted to leave the branch for the main line.

In the operation of a double track triangular junction, as shown in Diagram E, an east bound train from A to B will foul at I a train going from the main line west bound track to the branch west bound track; also at F a train going from the branch east bound track to the main line east bound track; also at K, a train going from the branch east bound track to the main line west bound track. Therefore, before a train intending to go from A to B is permitted to leave A, a west bound train going from the main line to the branch should be held at B, and an east bound train going from the branch to the main line, and a train going from the branch to the main line westbound track, should be held at O.

A west bound train going from B to A is fouled at D by a train going from the branch east bound track to the main line west bound track. Therefore, before

a west bound train is permitted to leave B, a train going from the east bound branch track to the main line west bound track should be held at O

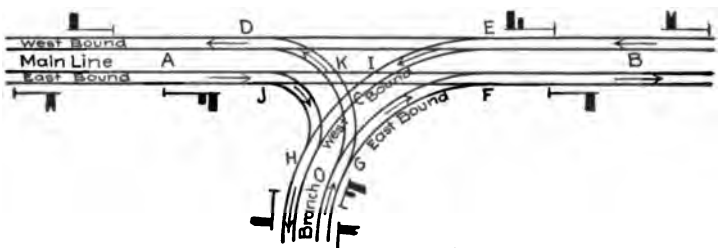


DIAGRAM E. DOUBLE TRACK TRIANGULAR JUNCTION.

A west bound train going from B to O fouls at C a train going from the branch east bound track to the main line west bound track; and at H a train going from the main line east bound track to the branch west bound track. It is also fouled at I by a train going from A to B. Therefore, before a train is per-

mitted to leave B for O, a train on the branch east bound track going to the main line west bound track must be held at O, and a train going from the main line east bound track to the branch west bound track, or from A to B, must be held at A.

At triangular junctions, if the junction connections are so far apart that the signals controlling them cannot be worked mechanically from one station, separate stations must be provided, one for each junction place. Where there are more stations than one the signals of all should be electrically interlocked, so that one station cannot permit a movement that would foul a movement permitted by another station.

From the above examples it follows, naturally, that in order to facilitate prompt movements, the blocks centering at a railroad crossing or junction should be as short as is consistent with safe working, because the closer trains are permitted to approach the crossing or junction when it is blocked, the less time will they lose in reaching it after permission has been given them to proceed.

The Erie Railroad Company's rules governing interlocking switches and signals are given below:

"The normal position of switches is for the main or most important route. The

normal position of signals is 'danger.' When no movement is contemplated, switches and signals must be kept in their normal position.

"Inability to get a signal for a movement after switches have been set, indicates that something is wrong with the interlocking. The signal-man must then go on the ground and examine the switches. If they are properly set and locked, the engine-man must be given written orders and a hand signal to proceed carefully over the switches. If they are not properly set and locked, the signal-man must be careful to disconnect them and then properly spike the points to the rails, before instructing the engine-man to proceed. In such cases, all trains must be brought to a full stop before being allowed to pass over the switches.

"Should it become necessary to change the position of signals or switches after a signal has been given to a train the signal may be changed to 'danger;' but derails and switches on the route given must not be opened, and no signal must be given to a train on a conflicting route, until the train which first received the signal has come to a full stop.

"In case of a derailment, no train must be allowed to pass over the switches until they have been thoroughly inspected, tried and found to be all right.

"It must always be seen that the signal works in harmony with the lever. When a signal fails to work properly, it should be fastened at 'danger,' and its use discontinued until it has been put in proper order.

"Great care must be exercised in operating switches during snow-storms. If no track-men are on hand to keep the switches clear of snow, the superintendent should be notified at once.

"During cold weather, the levers must be frequently moved in order to prevent freezing. This should not be done when a train is approaching.

"Signal-men will be held responsible for the proper care of the tower, interlocking, lamps and supplies. Should the person assigned to look after them fail to do so properly, signal-men must report the fact.

"Trains running on the left-hand track are not governed by the same switch-signal as they would be were they running on their own (right-hand) track; but are governed by the switch-signal on the track on which they are running during the irregular movement.

"'Flying' switches must never be made.

"Before switches or signals are thrown for any train or engine, signal-men

must know the movement to be made, that the route is clear for such movement, and that such train or engine is clear of the detector bar.

"When switches or signals are undergoing repairs, signals must not be given for any movement until it has been ascertained, from the repairers, that the switches are properly set for such movement.

"Lights in a tower must be so placed that they cannot be seen by an approaching train.

"Night signals shall be displayed from one hour before sunset until one hour after sunrise, and also when, by reason of storms, fog or other causes, the day signals cannot be clearly seen.

"Lever-men or signal-men must not make any change in the machine in the tower, or in the groundwork outside.

"Report at once, by telegraph, to the superintendent, all failures of signals or switches, or any part of the interlocking plant, to work properly, stating as clearly as possible the trouble."

CHAPTER X.

MANUAL BLOCKING.

In manual blocking each signal-man controls the block signals at his station.

The code signalling between the block stations is generally done by means of electric bells, although it can be done by the slower method of Morse telegraphing.

British lines also use, in manual blocking, an "indicator," giving a visual indication of the condition of the block. The block station has, for each block, an indicator connected by an electric circuit with a similar instrument at the other end of the block. On the dial of the indicator appear the words "line clear," "train on line," and "line closed." By placing the hand of the indicator over any of these formulas the instrument at the other end gives a like indication. The instrument is not interlocked with the out-door signals. The term "line closed" means that

the instrument is out of service as there is no traffic in the block for the time being. This is the normal position of the pointer, giving a negative indication. When a train has to be signalled the pointer is moved to one side or the other, giving a positive indication.

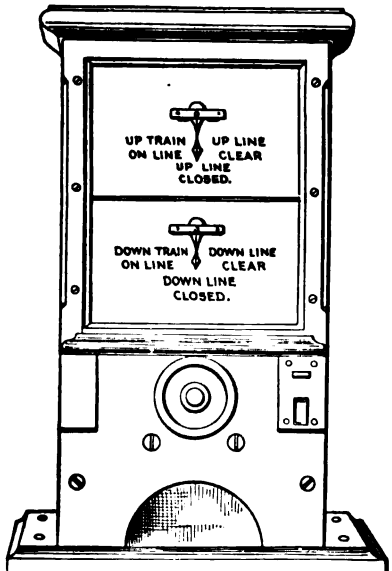
This indicator is thus described by the late Sir George Findlay, (general manager of the London and Northwestern Railway), in his work entitled "The Working and Management of an English Railway:"

"A block instrument of any kind consists of an indicating dial and a commutator or handle. The indicator is attached to an axle, on which a magnet is centered, being suspended either within, or in close proximity to, a coil of silk-covered wire, and deflected to the right or left according to whether a 'negative' or 'positive' current flows through the coil. The commutator is so arranged as to alter the direction of the current at will. The bells are generally of the single stroke type, and are used for calling attention, and for giving the complete code of signals descriptive of the nature of trains, as agreed to by all the railway companies.

"The normal state of the indicator of the three-wire block instrument is vertical ('line closed') when no current is flowing; the deflection when a negative

current is flowing is to the right, meaning 'line clear,' and with a positive current to the left, indicating 'train on line.'

"Briefly the *modus operandi* is as follows: Attention is first called on the bell, and then station A will give to station B what is called the 'be ready' signal, consisting of a certain number of strokes of the bell, varying so as to indicate the nature of the train. The man at station B, if the previous train has passed his cabin and he knows the section between A and B is clear, repeats this signal. The train is then despatched from A, the signal-man at A gives the signal 'train on line,' the signal-man at B acknowledges this by moving his own indicator and the one at A to 'train on line,' and at once gives the 'be ready' signal to C, and so on throughout. As soon as the train has passed B the man at B moves his own indicator and the one at A over to 'line clear,' and upon this being acknowledged by A the indicator is left vertical, signifying 'line closed,' and thus the operation has been completed so far as that particular train and that particular section are concerned. Of course it will be apparent that if this system is properly carried out, it is an absolute impossibility for two trains to be between A and B at the same time."



FLETCHER'S COMBINED BLOCK TELEGRAPH APPARATUS AND BELL.

The rules of the London & North Western Railway, in England, and of the Erie Railroad, in this country, are given further on, and are examples of good practice in manual blocking on double and single track lines. The rules of the latter road are used in its controlled manual blocking also. The general principles of absolute blocking on the London & North Western Railway may be expressed thus:

A second train or engine must not be allowed to enter a section until the preceding train or engine has been signalled as having passed out of the section, except under the circumstances specified in the rules to meet cases of train or telegraph failure. The "danger" signal must be exhibited at both the home and distant signals to protect trains or engines standing at stations or intermediate signal-boxes; and when any train or engine has gone forward into the onward section, the starting and advanced starting signals (where such are provided), which control the entrance of trains and engines into such section, must also be put to, and kept at "danger," until telegraphic information has been received from the signal-box in advance that the preceding train or engine has passed out of the section, and it is again necessary to lower them for a following train to pass after the prescribed telegraphic signals have been exchanged with the signal-box in

advance, or as the company's regulations may require. So long as the starting signals stand at "danger" the home and distant signals must also be kept at "danger," except on the near approach of a train which has to stop at the station, when, after the speed of the train has been reduced so as to admit of its stoppage at the platform, the home signal may be taken off to admit the train, but the starting signal must be kept at "danger" until the line is clear to the next signal station ahead.

REGULATIONS OF THE LONDON AND NORTH WESTERN RAILWAY FOR TRAIN SIGNALLING BY BLOCK TELEGRAPH ON DOUBLE LINES OF RAILWAY.

BELL SIGNALS.

SEE RULE.		BEATS ON BELL.	HOW TO BE GIVEN.
1	Call attention	1	1.
3 & 4	Train entering section	*2	2 consecutively
	Is line clear for express passenger train, or breakdown van train going to clear the line, or light engine going to assist disabled train?	4	4 consecutively.
	Is line clear for ordinary passenger train, or breakdown van train not going to clear the line?	4	3 *pause* 1.
	Is line clear for branch passenger train?	4	1 *pause* 3.
	Is line clear for fish, meat, fruit, horse, cattle, or perishable train composed of coaching stock?	5	5 consecutively.
	Is line clear for empty coaching stock train?	5	2 *pause* 2 *pause* 1.

* See Rule No. 1 in regard to signals marked thus.

BELL SIGNALS.

SEE RULE.		BEATS ON BELL.	HOW TO BE GIVEN.
3 & 4	Is line clear for fish, meat, or fruit train composed of goods, stock, or express cattle or express goods train?	5	1 *pause* 4.
	Is line clear for ordinary goods or mineral train stopping at intermediate stations?	3	3 consecutively.
	Is line clear for branch goods train?	3	1 *pause* 2.
	Is line clear for through goods, mineral, or ballast train?	5	4 *pause* 1.
3, 4, & 7,	Is line clear for light engine, or light engines coupled together, or engine and break?	5	2 *pause* 3.
3, 4, 8, & 9	Is line clear for ballast train requiring to stop in section, goods train calling at intermediate siding in section, or plate-layers lorry requiring to pass through tunnel?	5	1 *pause* 2 *pause* 2.
10 & 12	Train out of section, or obstruction removed	3	2 *pause* 1.
6	Bank engine in rear of train	*4	2 *pause* 2.
12	Obstruction danger	6	6 consecutively.
13	Blocking back	6	*Inside* Home Signal—2 *pause* 4. *Outside* Home Signal—3 *pause* 3.
17	Stop and examine train	7	7 consecutively.

* See Rule No. 1 in regard to signals marked thus.

BELL SIGNALS.

SEE RULE.		BEATS ON BELL.	HOW TO BE GIVEN.
7A	Take off slot	7	3 *pause* 4.
18	Cancelling "is line clear" signal or "train entering section" signal?	8	3 *pause* 5.
18A	Last train signalled incorrectly described	8	5 *pause* 3.
19	Train passed without tail lamp	9	9 consecutively *to box in advance.* 4 *pause* 5 *to box in rear.*
20	Train divided	10	5 *pause* 5.
21	Shunt train for following train to pass	*11	1 *pause* 5 *pause* 5.
22	Vehicles running away on wrong line	12	2 *pause* 5 *pause* 5.
6	Cancel bank engine in rear of train	12	8 *pause* 2 *pause* 2.
5	Section clear, but station or junction blocked	*13	3 *pause* 5 *pause* 5.
23	Vehicles running away on right line	14	4 *pause* 5 *pause* 5.
24	Opening of signal box	15	5 *pause* 5 *pause* 5.
27	Testing block indicator and bells	16	16 consecutively.
24	Closing of signal box	17	7 *pause* 5 *pause* 5.
28	Time signal	18	8 *pause* 5 *pause* 5.
29	Lampman or fog signal-man required	19	9 *pause* 5 *pause* 5.
30	Testing slotted signals	20	5 *pause* 5 *pause* 5 *pause* 5.

* See Rule No. 1 in regard to signals marked thus.

A special "is line clear" signal for "through passenger trains" of 12 beats (thus, 4—4—4), and for "through goods trains" of 8 beats (thus, 4—4), will be adopted at some of the principal stations. These signals are only to be used at places authorized by the district superintendent.

For express goods and cattle trains requiring unusual dispatch, and carrying the authorized distinctive head signals, the "is line clear" signal will be given thus, 3—2. The district superintendent will specify the trains to which this signal will apply.

Telephone Code.—In cases of emergency, when it is necessary for the telephone to be attended to at once, the special code, 3—3—3—3, may be given on the block instrument bell, and any signal-man receiving this signal must immediately attend to the telephone. The special code may also be used when the telephone bell fails.

Block System.—The object of the system of block telegraph signalling is to prevent more than one train being in the section between two block signal boxes on the same line at the same time.

The signalling of trains on the block telegraph system does not in any way

dispense with the use of fixed, hand or fog signals, whenever and wherever such signals may be requisite to protect obstructions on the line.

Normal Position of Fixed Signals.—The danger signal must be kept exhibited at all the fixed signals, except when it is necessary to lower or turn them off for a train to pass; and before any signal is lowered or turned off, care must be taken to ascertain that the line is clear, and that the block telegraph and other regulations have been duly complied with.

Normal Position of Block Indicators.—When the block instruments are not in use the line must be considered blocked: the indicators being vertical or neutral.

Use of Block Instruments and Bells.—These must be used exclusively for the purposes shown in the block telegraph regulations, and must not, under any circumstances, be used for conversing. They must only be used by the signal-man or other person specially appointed for the duty.

The movements on the block instruments and bells must be made slowly and distinctly, and the pauses between the sets of beats clearly marked.

1. *Call Attention.*—Except in the case of bell signals marked * *the "call*

attention" signal must always be given before any other signal, and must be acknowledged immediately on receipt.

2. *Repetition and Acknowledgment of Signals.*—Except where special instructions are issued to the contrary, all signals must be acknowledged by repetition, and no signal must be considered as understood until it has been correctly repeated to the signal box from which it was received. When the "is line clear" signal is not acknowledged it must be given again at short intervals.

Note.—The "train entering section" signal must be acknowledged by placing the block indicator to the "train on line" position. The "train out of section" signal must be acknowledged by one beat on the bell.

3. *Mode of Signalling by Block Telegraph.* — A, B and C represent three consecutive block signal boxes, and the process of signalling a train is as follows:

Prior to the despatch of a train from A, the signal-man there, provided he has received the "train out of section" signal for the previous train, and the block indicator is in its normal position, must call the attention of B, and, having obtained it, must give the proper "is line clear" signal; if the line be clear at B,

the signal-man there must acknowledge the signal and place the block indicator to the "line clear" position.

The signal-man at A may then, if the line be clear, take off his signals for the train to leave A.

On the train leaving A the signal-man there must send the "train entering section" signal to B, and the signal-man at B must acknowledge the signal by placing the block indicator to "train on line."

B must then, provided he has received the "train out of section" signal for the previous train and the block indicator is in its normal position, call the attention of C, and, having obtained it, must give the proper "is line clear" signal to C. On receiving permission from C for the train to approach, B may take off his signals for the train to proceed to C; as soon as the train has arrived at or passed B, or been shunted clear of the main line at B, the signal-man there must call the attention of A, and, having obtained it, give the "train out of section" signal to A, placing the block indicator in its normal position; A must acknowledge this by one beat on the bell. (See Rules 4 and 10.)

Where the sections are short, the "is line clear" signal must, provided the

onward section is clear, be sent forward, where necessary to avoid delay to the train, as soon as it has been acknowledged, and before the "train entering section" signal has been received. Instructions on this point, and also respecting the "train entering section" signal, are laid down where necessary at the foot of the block card.

4. *Line Clear, or Giving Permission for a Train to Approach.*—Unless special instructions are given to the contrary, the line must not be considered clear, nor must a train be allowed to approach from the signal-box in the rear, in accordance with Rule 3, until the preceding train has passed at least a quarter of a mile beyond the home signal and is continuing its journey, nor until all the points over which the approaching train has to pass have been placed in their proper position, and the line is clear for at least a quarter of a mile ahead of the home signal.

Where the signal-box in advance is less than a quarter of a mile ahead, permission for a train to approach must not be given to the signal-box in the rear until the "train out of section" signal has been received from the signal box in advance.

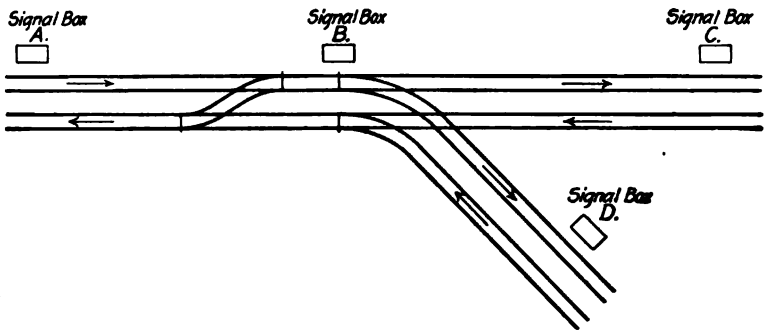
After permission has been given for a train to approach in accordance with Rule 3, no obstruction of the line on which such train requires to run must be

allowed until the train has been brought to a stand at the home signal, or has passed into the section in advance, or the "cancelling" signalling has been received from the signal box in the rear.

If the line be not clear, or if from any other cause the signal-man be not in a position to give permission for the train to approach when the signal-man in the rear forwards the "is line clear" signal, that signal must not be acknowledged until the signal-man to whom the signal has been sent is prepared to receive the train, when he must give permission for it to approach in accordance with the prescribed regulations.

During Fogs or Falling Snow.—Except where special instructions are given to the contrary at the foot of these regulations, when a fog comes on, or when snow begins to fall, and until the fogmen arrive at their posts, the "is line clear" signal must not be accepted from the box in the rear unless "train out of section" has been received from the box in advance for the preceding train, and the onward section is clear. This instruction will also apply at places where fogmen are not provided. If the "blocking back" signal has been received from the box in advance and acknowledged, permission must not be given for any train to approach from the

box in rear; nor if such permission has been given for a train to approach from the box in rear, must permission be given for the box in advance to "block back."



JUNCTION ON THE LONDON AND NORTHWESTERN RAILWAY.

4*a*. *At Junctions.*—Except where otherwise provided at the foot of these instructions, the approach of trains, which can cross or foul each other, is regulated as shown in the above illustration.

When permission has been given by B for a train to approach from C, no train must be allowed to leave D until that from C has been brought to a stand at the home signal, or has passed through the junction for a distance of a quarter of a mile, or until the "train out of section" signal for the previous train has been received from the next signal box ahead if within that distance; nor in such a case must a train be allowed to leave A for D unless the junction facing points at B are set for C, and the line towards C is clear for a distance of a quarter of a mile beyond the junction points or until the "train out of section" signal for the previous train has been received from the next signal box ahead if within that distance.

When permission has been given by B for a train to approach from D, no train must be allowed to leave C until that from D has been brought to a stand at the home signal, or has passed through the junction for a distance of a quarter of a mile, or until the "train out of section" signal for the previous train has been received from the next signal box ahead if within that distance.

When permission has been given by B for a train to approach from A for D, no train must be allowed to leave C until that from A has been brought to a stand

at the home signal, or has passed clear of the junction, or the junction facing points have been set for C, and the line towards C is clear for a distance of a quarter of a mile beyond the junction points, or until the "train out of section" signal for the previous train has been received from the next signal box ahead if within that distance.

When a train has been sent to the starting signal, and the rear of the train is well clear of the junction, permission for a following train to approach may be given by the signal-man to the signal box in the rear, if the points are set for the following train to pass on to another line and that line is clear.

5. *Section Clear, but Station or Junction Blocked.*—("Warning arrangement.") (This signal must only be used as laid down in Rules 8 and 9, and where it is specially authorized by a note at the foot of the block card.) When the line is clear to the home signal, and it is necessary for a train to be allowed to approach cautiously in consequence of an obstruction existing ahead of the home signal, or from any other cause, the "is line clear" signal must not be acknowledged in accordance with Rule 3, but the "section clear, but station or junction blocked" signal must be given, and when this signal has been acknowledged the block indicator

must be placed to the "line clear" position. The signal-man receiving the signal must (if the train has not already passed the home signal towards the starting or advance starting signal) bring the train to a dead stand at the home signal, and verbally instruct the driver that the section is clear, but the station or junction ahead is blocked. A green hand signal must at the same time be exhibited to the driver, and the necessary fixed signals lowered to give permission for the train to proceed. The "train entering section" signal must then be given, and acknowledged by placing the block indicator at the "train on line" position.

Where the home signal is at such a distance from the signal box that it is not possible for the signal-man to communicate verbally with the driver when the engine is standing at the home signal, the signal-man must, after bringing the train to a dead stand at the home signal, lower it to allow the driver to draw up to his signal box, and must stop the train at the signal box by exhibiting a red flag by day and a red light by night. The driver must then be verbally instructed that the section is clear, but the station or junction ahead is blocked; after which a green hand signal must be exhibited to the driver, and the necessary fixed signals lowered to give permission for the train to proceed.

If a train is assisted by an engine in the rear, a green hand signal must also be exhibited to the driver of the engine in the rear of the train.

Except where special instructions are issued to the contrary, when a train has passed the signal box and is brought to a stand at the starting signal or the advanced starting signal to wait "line clear" from the box in advance, the driver must understand that the lowering of the starting signal or the advanced starting signal is an indication that the line is only clear to the home signal at the signal box in advance, and that he must regulate the speed of his train in the same way as if he had been verbally instructed to proceed under the "section clear, but station or junction blocked" signal.

When some time is likely to elapse before the train for which the "is line clear" signal has been sent will be ready to enter the section, the "section clear, but station or junction blocked" signal must not be acknowledged, but when the train is ready to enter the section, and before it is allowed to do so, the "is line clear" signal must be again sent, in order to give the signal-man at the box in advance an opportunity of receiving the train under Rule 3, if the circumstances are so altered as to admit of his doing so.

At places where the use of the "section clear, but station or junction blocked" signal is authorized, the bell signal (2—1) must be given as soon as the train has arrived within cover of the home signal with tail lamp complete, but the block indicator must remain at the "train on line" position until the train has proceeded at least a quarter of a mile beyond the home signal, or has been shunted clear of the main line, or until it is necessary to accept a following train under the "warning arrangement," in accordance with the first paragraph of this rule. When the block indicator is released from the "train on line" position, and no following train is being accepted under the "warning arrangement," one beat on the bell must be given to, and acknowledged by, the signal-man in the rear.

The signal-man at the box in rear of a station at which the "warning arrangement" is authorized may, after receiving the bell signal (2—1) from that station, send forward the "is line clear" signal, although the block indicator remains at the "train on line" position.

6. *Bank Engine* in Rear of Train.*—After the "train entering section" signal

* Helper or pusher engine.

has been given to the signal box in advance, and the indicator has been placed to the "train on line" position for a train that is assisted by an engine in the rear, the "bank engine in rear of train" signal must be given to the signal box in advance, to indicate that an engine is assisting the train in the rear. The "bank engine in rear of train" signal must be acknowledged, and a note of the signal must at once be made in the train register book at the signal box in advance and the "train out of section" signal must not be given until the assisting engine has arrived.

If from any cause the bank engine, after being signalled, does not proceed in the rear of the train the "cancel bank engine in rear of train" signal (8—2—2) must be sent to the signal box in advance.

If it is necessary for the train to be cancelled as well as the bank engine, the authorized "cancelling" signal, 8 beats (3—5), must be given, in accordance with clause 18 of these regulations, and this will cancel both the train and the bank engine.

"Train out of section" for a train assisted by a bank engine must not be given until the bank engine arrives, or if the signal "cancel bank engine in rear of

train" (8—2—2) has been received, until the train with tail lamp complete has passed.

7. *Engines Coupled Together.*—Whenever it may be necessary to detach one engine from another on the main line, the driver of each engine requiring to be detached must, before uncoupling, verbally communicate with the signal-man and make him clearly understand what is about to be done, and in what direction the uncoupled engine or engines will proceed.

When two or more engines are coupled together, the first one must be signalled as a light engine, the "is line clear?" signal (2—3) being given and accepted in the ordinary way, and after the "train entering section" signal has been given, the other engine or engines must each be signalled by the bank engine code (2—2), the signal for each engine being acknowledged by 1 beat. The cancelling code (8—2—2) must be used to cancel each engine not going forward attached to the first engine after having been signalled. If it is necessary for all the engines to be cancelled, the ordinary "cancelling" signal (3—5) must be used.

7A. *Take off Slot.*—The code (3—4) is to be given when a train has been brought to a stand at a junction or in a station yard, and the home signal cannot

be lowered in consequence of the slot being on from the signal box in advance. When the slot has been taken off, the train may be allowed to proceed cautiously, the signal being lowered and a green hand signal shown to the driver by the signal-man. This code must not be given until the train has been brought to a stand, and the train must be kept waiting until the slot is taken off.

8. *Ballast Train Requiring to Stop in Section.*—When a ballast train has to stop in a block section for permanent-way purposes, the signal-man must give the prescribed "is line clear" signal, and the signal-man at the box in advance must, if the line be clear to the home signal, give permission for the train to approach his box in accordance with Rule 5. When a ballast train, which has been signalled as a through ballast train, requires to stop in the section for permanent-way purposes, and comes to a stand at a signal box to enable the guard to inform the signal-man that his train is going to stop on the main line in the section in advance, the signal-man must give the "cancelling" signal (3—5), and when the signal has been acknowledged, he must signal the train as a "ballast train requiring to stop in the section."

*Goods Trains *Calling at Intermediate Sidings in Block Sections.*—Where authorized by the district superintendent in the special instructions at the foot of the block card, goods trains which have to call at intermediate sidings in a block section to do work must be signalled in the same manner as a ballast train having to do work in the section, and must be accepted by the box in advance in accordance with Rule 5.

9. *Platelayers' Lorries† Going Through Tunnels.*—When it is necessary for a platelayer's lorry to go through tunnels, it must be signalled on the block instruments in accordance with the authorized code, and the signal-man at the box in advance must, if the line be clear to the home signal, give permission for the lorry to approach his box in accordance with Rule 5. No train must be allowed to enter the tunnel on the same line until the "train out of section" signal has been received from the signal box in advance, to indicate that the lorry has left the tunnel and has passed the next block signal box, or been taken off the rails. Should the lorry after passing the tunnel, be removed from the rails before reaching the next signal box, the ganger‡ must go forward and inform the signal-man that the lorry is clear

* Freight trains. † Trackmen's hand cars. ‡ Trackman.

of the line. If, however, time would be saved, the ganger must return to the signal box in the rear and inform the signal-man that the lorry is clear of the line; the signal-man must then send the "cancelling" signal to the signal box in advance.

10. *Train out of Section* (2—1 on the bell, and block indicator placed in its normal position).—(*a*) Except where specially authorized by the district superintendent at the foot of the block card, the "train out of section" signal must not be given to the signal-box in rear until the train with tail lamp complete has proceeded on its journey at least a quarter of a mile beyond the home signal and is continuing its journey, or has been shunted clear of the main line. See 6th clause of Rule 5 as to the bell signal, 2—1, being used at places where the "warning arrangement" is authorized.

(*b*) When the last vehicle of a train does not pass the signal box before it has been shunted into a siding, or when a train has been brought to a stand within the home signal, and it is necessary to give the "train out of section" signal before the train passes the signal box, the signal-man must, before giving such signal, ascertain from the guard or shunter in charge of the train that the whole of the train, with tail lamp attached, has arrived, and the guard or shunter will be held

responsible for giving this information to the signal-man; the fireman being similarly responsible in the case of a light engine.

11. *Course to be Pursued when a Train is an Unusually Long Time in a Section.*—Should an unusual time elapse after the "train entering section" signal has been received without the train so signalled arriving, the signal-man must, if there is a tunnel in the section in which the train is running, prevent any train in the opposite direction proceeding on its journey until he has ascertained that the line on which it has to run is clear; and if there is no tunnel in the section, the signal-man must stop the first train proceeding in the opposite direction, and inform the driver of the circumstance, and, after the necessary signals have been sent and acknowledged, instruct him to proceed with caution.

12. *Obstruction Danger Signal.*—Should it be necessary, in consequence of obstruction or other cause, for an approaching train to be stopped at the signal box in the rear, the "obstruction danger" signal must be forwarded to that box, and the signal-man there must immediately exhibit the "danger" signal and take the necessary measures to stop the approaching train; he must not allow the train to proceed until he has received from the signal box in advance the "obstruction

removed" signal, and the block indicator has been placed in its normal position, nor until the proper block signals have been sent and acknowledged.

Should there be reason to suppose that both lines are fouled, the signal-man must send the "obstruction danger" signal in both directions, and where there are parallel running lines, the requisite steps must be taken to stop the trains running on any line that may possibly be obstructed.

Should a signal-man receiving the "obstruction danger" signal succeed in stopping a train for which the "is line clear" signal has been accepted by the signal-man at the box in advance, he must at once advise the signal-man at that box by giving the "cancelling" signal; this signal must be acknowledged, but the block indicator must remain at the "train on line" position until the obstruction has been removed.

The signal-man forwarding the "obstruction danger" signal must place the block indicator for the line or lines affected to "train on line," if not already in that position, and must also place or maintain his signals at danger to protect the obstruction.

13. *Blocking Back.*—When it is necessary, after the passing of one train and

before giving permission for another to leave the signal box in the rear, to obstruct the line inside the home signal, by crossing a train or vehicles from one line to another for shunting purposes, or by allowing a train or vehicles to leave a loop line or siding for the main line, the "blocking back" signal (2—4) must, unless instructions are issued to the contrary, be given to the signal box or boxes in the rear, and, on this being acknowledged by repetition, the block indicator for the line or lines intended to be occupied must be placed at the "train on line" position.

When a signal-man requires permission to occupy the line *outside* his home signal, he must give the "blocking back" signal (3—3) to the signal-man at the box in the rear, and the latter must, before acknowledging by repetition the "blocking back" signal (3—3), satisfy himself that he can with safety give such permission, and that he has not allowed a train to approach his signal box from the signal box in the rear under Rule 3, unless there is a distance of at least half a mile between his home signal applicable to such train and the signal box from which he has the "blocking back" signal, or, if at a junction, he has set his facing points for another line and that line is clear according to these regulations. The

block indicator for the line or lines intended to be occupied must be placed at the "train on line" position.

If, when a signal-man gives the "blocking back" signal for the purpose of asking permission to occupy the line, the signal-man at the box in the rear is not in a position to give such permission, he must not repeat the "blocking back" signal, or acknowledge it in any way, and until the signal has been ackowledged the line must not be occupied.

Unless special permission is given, no train or vehicle must be placed outside a home signal where the line is on a falling gradient towards the signal box in the rear.

When the obstruction has been removed, and the main line or lines are again clear, the "obstruction removed" signal must be given to the signal box in the rear, and the block indicator placed in its normal position; this must be acknowledged by the signal-man at the box in rear giving one beat on the bell.

When the "blocking back" signal has been giving for shunting operations inside the home signal, the signal-man in rear is not prohibited from sending the "is line clear" signal if he has a train approaching, but the "is line clear" signal must

not be forwarded when the "blocking back" is for the occupation of the line outside the home signal at the box in advance.

The signal-men forwarding and receiving the "blocking back" signal must make a note of the circumstance in their train register books, showing which "blocking back" signal has been used.

14. *Section Obstructed by Accident or by Disabled Train.*—Should a signal-man receive information from the fireman or guard of a disabled train, or by speaking instrument from the signal-man at the box in advance, that a second train is required to enter the section to assist the disabled train, or should it be necessary for the breakdown van train (wrecking train) to enter a section obstructed by accident or otherwise, the second train or the breakdown van train, as the case may be, may, after having been brought to a stand and the driver informed of the cirumstances, be allowed to enter the section under the following arrangements:

The signal-man must inform the signal-man at the box in advance of the circumstances, and give the "train entering section" signal on the bell to the signal-box in advance; and after it has been acknowledged by one beat on the bell, he must note the circumstance in his train register book, and then allow the second train

to enter the section. The signal-man at the box in advance must also note the circumstance in his train register book, and must not give the "train out of section" signal until both trains have arrived. The guard or fireman of the train requiring assistance must ride on the engine of the second train, and point out to the driver the position of the disabled train. The second train must run at reduced speed, and great caution must be observed by all concerned. When the "train out of section" signal is received from the signal-box in advance, and permission has been obtained for another train to proceed, such other train must be stopped at the signal-box in the rear, and the driver instructed to proceed cautiously through the section.

15. *Breakdown Van Trains* and Engine replacing or assisting Disabled Engine.* —To prevent delays, breakdown van trains when proceeding to clear the line, must be signalled as express passenger trains, the "shunt train for following train to pass" signal be given whenever the sections in advance are occupied by trains which the breakdown gang must pass to reach the scene of accident.

The same course must be adopted in the case of one engine proceeding to

* Wrecking Trains.

take the place of another that has failed, or of an engine, with or without a train, when sent forward to render assistance in case of failure or accident to preceding trains. The assisting engine must carry express passenger train head signals.

Engineer's Special Trains Running to the Scene of an Accident or Blockage of Line.—Engineer's specials going to the scene of an accident are to be treated in the same way as breakdown van trains, and must be permitted to enter blocked sections under the same regulations when the lines are in possession of the engineering department, or are blocked for repairs or other works. In the case of single lines the driver must be in possession of the train staff when entering the blocked section, or if working by pilotman is in operation he must wait for the pilotman.

16. *When Block Telegraph may be Suspended for Single Line Working.*—Should any obstruction occur necessitating the working of single line, and it is necessary to suspend block telegraph working, this must be done only by an order in writing from the person in charge who arranges the single line working; but during foggy weather or falling snow, or when a tunnel intervenes, or the gradients are heavy on the section of the line where the traffic has to be worked on a single

line, block telegraph working must be maintained, the up trains being signalled on the up line block telegraph circuit, and the down trains on the down line block telegraph circuit, or the pilotman must accompany every train passing over the single line. On the working of the double line being resumed, any order suspending the working of the line by block telegraph is to be cancelled by a written notice in the same manner and at the same time as the order for working single line is cancelled.

17. *Stop and Examine Train.*—If a signal-man observes anything unusual in a train during its passage, such as signals of alarm by a passenger, goods falling off, a vehicle on fire, a hot axle box, or other mishap, except a tail lamp missing or out, or a train divided, for arrangements as to which see Rules 19 and 20, he must give to the signal-man at the signal box in advance the "stop and examine train" signal, and must himself exhibit his signals to stop any train coming in the opposite direction; and the signal-man at the signal box in advance must acknowledge such signal, and immediately exhibit the danger signals to stop any train coming from or going towards the signal box from which the signal was received. The train, when stopped, must be carefully examined and dealt with as occasion may

require; should any train going in the opposite direction have been stopped by either signal-man, it must be allowed to proceed after satisfactory evidence has been obtained that the line on which it is about to run is not obstructed.

Should the signal-man who receives the "stop and examine train" signal be unable to ascertain after examination of the train why the signal was sent, he must inform the driver of the first train travelling in the opposite direction of the circumstances, and instruct him to proceed cautiously to the next signal box.

Where practicable, the signal-man must also telegraph or telephone the signal box in advance the cause of sending the "stop and examine train" signal. Signal-men must be careful to notice each train as it passes, to ascertain whether there is any apparent necessity for having it stopped at the next signal box for examination.

Should either signal-man have reason to believe, in the case of a vehicle being off the rails or goods falling from the train, that the permanent way has been damaged or fouled, he must not allow any train to proceed in the direction of the obstruction until the line has been examined and he is satisfied that it is safe for the passage of the train.

18. *Cancelling Signal.*—Should it be necessary to cancel the "is line clear" or the "train entering section" signal, the "cancelling "signal (3—5) must be forwarded, and the signal-man receiving the signal must, after acknowledging it, place the block indicator in its normal position (except under the circumstances named in Rule 12), and an entry must be made in the train register book recording the fact of the signal having been cancelled. The "cancelling" signal must not be used unless the "is line clear" or the "train entering section" signal has been acknowledged, and must only be used in cases where a train has been signalled to the signal box in advance and it is found that such train will not proceed in the usual course.

18A. *Last Train Signalled Incorrectly Described.*—For the purpose of correcting an "is line clear" signal, should a wrong description of train have been sent forward, the signal-man wishing to alter it must do so by giving 8 strokes on the bell (5—3), signifying "last train signalled incorrectly described," to the signal box in advance, which signal must be acknowledged. The correct "is line clear" signal must then be forwarded and acknowledged in the ordinary manner. The position of the block indicator must not be interfered with.

19. *Train passed without Tail Lamp.*—All trains and light engine will carry a tail lamp in the rear, both by day and by night, to indicate to the signal-man that no vehicle has become detached on the journey, and signal-men must carefully watch each train as it passes, and satisfy themselves that it is complete before giving the "train out of section" signal to the signal box in the rear. Should a train pass a signal box and the signal-man be unable to satisfy himself whether or not the tail lamp is on the train, he must immediately exhibit the danger signal, and stop the first train going in the opposite direction, informing the driver what has occurred, and instructing him to proceed cautiously so as to avoid danger in the event of any portion of the train having fouled the line on which he is running. The signal-man must also send the "train passed without tail lamp" signal (9 consecutive beats) to the signal box in advance, and must not give the "train out of section" signal to the signal box from which the train without tail lamp has arrived, but must give the "train passed without tail lamp" signal (4—5).

In such a case the signal-man at the box in the rear may give the "is line clear" signal for a following train, although he has not received the "train out of section" signal.

The signal-man at the box in advance, on receiving the "train passed without tail lamp" signal, must acknowledge it, and place the signals at danger to stop the approaching train, advising the guard and driver of the circumstances. If, where the sections are short, a signal-man receiving the "train passed without tail lamp" signal of 9 consecutive beats finds that he cannot stop the train except by bringing it to a sudden stand, he must not place his signals to danger, but, as the train is approaching, send the "train entering section" signal to the signal box in advance, and *immediately* follow it with the "train passed without tail lamp" signal.

When the signal-man who sent the "train passed without tail lamp" signal (4—5) receives the "is line clear" signal for the following train (unless in the meantime he has received intimation from the signal box in advance that the train has arrived complete, he must not acknowledge it in the usual way, but must repeat the "train passed without tail lamp" signal (4—5), and maintain the block indicator at the "train on line" position. The signal-man in the rear receiving this signal must stop the train and verbally instruct the driver to proceed cautiously to the next signal box in advance, informing him why it is necessary that he should do so, and then give the "train entering section" signal, which must be acknow-

ledged by one beat on the bell. As soon as the train, the driver of which has been cautioned, has passed the signal box from which the "train passed without tail lamp" signal was sent, the signal-man there must give the "train out of section" signal, and the signalling of the trains must then be resumed in the ordinary manner, the circumstance being specially reported.

Should, however, the signal-man sending the "train passed without tail lamp" signal receive an intimation from the signal box in advance that the train has arrived complete, he must, if he has not in the meantime given permission for a following train to leave the signal box in the rear, call the attention of the signal-man at that box, and give the "train out of section" signal. If the train is not complete, the signal-man at the box in advance must so inform the signal-man at the box in rear on the speaking instrument.

If a train should pass with a tail light out when it should be burning, and the signal-man can plainly see the tail lamp, and is satisfied that the train is complete, or should the train be carrying improper side lights, he must give the "train out of section" signal to the signal box in the rear, and the "train passed without tail lamp" signal (9 consecutive beats) to the signal box in advance, and, where prac-

ticable, also telegraph or telephone to the signal box in advance, stating that the lamp is not missing but out, or that the train is carrying improper side lights, as the case may be. In such a case it will not be necessary for the signal-man sending the signal to stop any train going in the opposite direction, but the signal-man in advance must stop the approaching train and inform the guard of the circumstances.

20. *Train Divided.*—This signal must be sent to the signal box in advance in the event of a signal-man observing that a train has become divided, and is running in two or more parts. The signal-man sending this signal must also stop any train going in the opposite direction. If the divided train is assisted by a bank engine* in the rear, or is running on a falling gradient, or between short sections where the stoppage of the first part would risk a collision with the second part, the signal-man receiving such signal must immediately exhibit the danger signal to stop any train going towards the signal box from which the signal was received, but if the line on which the divided train is running is clear ahead for it to run upon, he must not stop the first portion, but must give the driver a green signal,

* Helper or pusher engine.

either by flag or hand lamp, as occasion may require, waving the signal slowly from side to side. The driver, on seeing the green signal waved slowly from side to side, will understand that his train is divided, and must exercise great caution by looking out for the second portion, and unless he has reason to believe the line is not clear ahead, must not stop the portion attached to his engine until he is satisfied that the rear portion has been stopped, or is running very slowly. He must, however, observe and obey any signals that may be exhibited against him. So soon as the first portion of the train has passed, the signal-man sending and receiving the "train divided" signal must take proper measures for dealing with the second portion, put the signals to "danger" and place detonators on the rails to attract the attention of the guard, or of the bank engine driver should there be a bank engine in the rear.

If the divided train is running on a rising gradient, or where the line is level, and is not assisted by a bank engine in the rear, the signal-man receiving the signal must exhibit the "danger" signal to stop any train coming from or going towards the signal box from which the signal was received. The first portion of the divided train, when stopped, must be shunted into a siding as expeditiously as

circumstances will permit, or otherwise dealt with as may be necessary to prevent the second portion coming into collision with it.

Should any train going in the opposite direction have been stopped by either signal-man, it must not be allowed to proceed until it has been ascertained that the line on which it is about to run is not obstructed.

Should a train become divided in starting, and the driver run forward with the first portion, leaving the rear portion stationary, the "stop and examine train" signal must be sent to the signal box in advance, and not the "train divided" signal.

21. *Shunt Train for Following Train to Pass.*—This signal must be used to prevent important trains being delayed by less important trains. When, before the "train out of section" signal has been received from the signal box in advance for the last train, the signal-man receives a signal from the box in the rear for a more important train, the "shunt" signal must be sent to the signal box in advance, and the signal-man there, on receiving this signal, must take the necessary measures to clear the line, so as to prevent delay to the second train. He must use his discretion as to the best means of effecting the object in view, and if he is unable

from any cause to shunt the train at his signal box, or if he thinks it inexpedient to do so, he must allow the train to proceed, and send forward the "shunt" signal to the signal box in advance. The signal-men forwarding and receiving the "shunt" signal must make a note of it in their train register books.

22. *Vehicles Running Away on Wrong Line.*—Should any vehicle or portion of a train be running back in the wrong direction, or should a train be proceeding on the wrong line, the signal-man must immediately exhibit the danger signal, and call the attention of the signal-man at the next box towards which the vehicle, train, or portion of the train may be running, by giving the "vehicles running away on wrong line" signal; he must also stop the first train going in the same direction on the right line, and after informing the driver what has occurred, instruct him to proceed cautiously. (See note as to sections where catch points exist.) The signal-man in the rear receiving this signal must immediately exhibit the danger signal to stop any train coming from or going towards the signal box from which the signal was received, and take any other measures that may be necessary, such as turning the runaway train or vehicles across to the other line, or into a siding, as may be most expedient under the circumstances. In the event of a runaway train

or vehicles being turned across to the other line, the "vehicles running away on right line" signal must be passed on to the next signal box. Should the signal-man be unable to take such protective measures, he must pass on the "vehicles running away on wrong line" signal to the next signal box in the rear, he must also place detonators on the rails to attract the attention of the men in charge of the train or portion of the train.

Should any train travelling in the opposite direction be stopped, it must not be allowed to proceed until it has been ascertained that the line on which it is about to run is not obstructed.

The signal-man at the box from which the runaway train has started, or any other signal-man whose box may be passed by the runaway train, must immediately give the "obstruction danger" signal to the signal-man in the rear before giving the "vehicles running away on wrong line" signal, as prompt action on the part of both signal-men may prevent a mishap. Should the signal-man receiving the "obstruction danger" signal succeed in stopping the train or engine for which he has given the "is line clear" signal, he must at once advise the signal man in advance by giving the "cancelling" signal.

NOTE.—Should runaway "catch points"* exist in the section, on the line on which the vehicles are running back, no train travelling in the same direction upon the right line must be allowed to enter the section until satisfactory evidence has been obtained that the line upon which the train is about to travel is free from obstruction.

23. *Vehicles Running Away on Right Line.*—If any train, vehicle, or portion of a train has escaped and is running away in the proper direction on the right line, or has entered the section without authority, the signal-man at the box in advance must be advised of the fact by the signal-man at the box in the rear, giving the "vehicles running away on right line" signal. The signal-man forwarding this signal must immediately exhibit the danger signal to stop any train coming from or going towards the signal box towards which the vehicle or train is running; the signal-man receiving the signal must also immediately exhibit the danger signal to stop any train coming from or going towards the signal box from which the signal was received (unless there is a train in block in the same section as the runaway vehicle or train and in front thereof, in which case, if the line be clear, such

* Automatic derailing switch.

train may be allowed to pass the signals before they are exhibited to stop the runaway train), and he must arrange for the line on which the vehicle or train is running to be cleared, and, if necessary, send the signal forward, and take such other measures as he may consider most expedient under the circumstances. Should any train travelling in the opposite direction be stopped by either signal-man, it must not be allowed to proceed until satisfactory evidence has been obtained that the line on which it is about to run is not obstructed.

24. *Opening and Closing of Signal Boxes Where Switches are Provided.*—At signal boxes open during certain times, switches are provided to enable the block instruments on either side to be "put through" when the box is closed. The signal-man, on taking duty, must open the switch and give notice to the boxes he communicates with by 15 beats (5—5—5) on the bell, which must be acknowledged, and he must then place his indicators for the rear section in accord with the indicators for the section in advance. He must be careful not to put the signals to "danger" in face of a train which may be travelling in the section towards him.

If at the time the switch is opened the block indicator from the box in advance shows "train on line," the signal-man must not give the "train out of section"

signal until the train has passed his signal box, or the "train out of section" signal has been signalled from the box in advance.

When the time for leaving duty arrives, the signal-man must not switch his apparatus out of circuit until "train out of section" has been received from the box in advance for the train for which the "is line clear" signal was last accepted by him from the box in the rear. When that is the case the code of 17 beats (7—5—5) on the bell must be given and acknowledged, and the switch may then be closed.

The times of opening and closing must be entered in the train register book.

The signal-man must ascertain by speaking instrument from the boxes on either side, whether there are trains running in the sections at the time of opening the block telegraph switch.

No box must be switched out when any failure exists in connection with the interlocking apparatus, instruments or bells, nor in the event of a failure having been rectified, until the last train allowed to enter the section with a "caution" signal has passed through.

When a signal box is kept open beyond the usual time, for any cause, or when

a box that is only switched in when required is open, the signal-man at that box must not accept the "is line clear" signal for any train unless he has got that signal accepted by the box in advance. If the "is line clear" signal has not been accepted by the box in advance, the train must be accepted, in accordance with Rule 5, under the "warning arrangement," if the use of that signal is authorized; and the signal-man receiving the "warning" signal must advise the driver that the box in advance, usually switched out, is open. This instruction will not apply in the case of signal boxes which are specially opened in accordance with the notices issued by the district superintendent.

25. *Failure of Instruments or Bells.*—In the event of any failure of the instruments or bells, so that the necessary signals cannot be forwarded and received, no train must be allowed to pass a signal box into that section of the line where the failure exists, without having been previously brought to a dead stand, and the driver and guard or guards advised of the circumstance. The driver must then be instructed to proceed cautiously, in order to stop short of any obstruction there may be on the line. Where there are no speaking instruments, or when the speaking instruments have failed, the driver of the first train thus

warned must be instructed to stop at the signal box in advance and inform the signal-man there that the bells or instruments have failed at the signal box in the rear.

No train must be allowed to follow another train within *five* minutes, unless the signal-man sees that the section ahead is clear; and when a tunnel intervenes in a block section, not within *ten* minutes, unless the signal-man can satisfy himself that the tunnel is clear; in both cases the driver must be stopped and cautioned as above directed. Steps must be immediately taken to have the telegraphic apparatus put into working order, and when the failure has been remedied, and the instruments are again in working order, the driver of the last train allowed to proceed in either direction through the section cautiously must be supplied with a written notice to that effect, and instructed to stop at the next signal box then open, and hand the notice to the signal man. The signal man receiving this notice must give the "train out of section" signal to the signal box in the rear, and the signalling must then be re-commenced in accordance with these regulations.

Special instructions as to the intervals of time to be observed will be given by the district superintendent for those portions of the line where the gradients are severe or the sections are long.

In the event of the block instruments failing, certain companies will, in addition to stopping the train dead before allowing it to enter the section, send the necessary signals as messages on the single needle or telephone instruments, where such exist.

26. *Recording Time when Signals are Forwarded and Received.*—Except where special instructions to the contrary are issued, the time at which all signals are forwarded and received must be made legibly with a pen in the train register book, and the signal-man on duty must place his name immediately under the last entry made by him at the expiration of his hours of duty.

If an incorrect entry be made, a line must be drawn lightly through it, and the correction made above or below it, so that the original entry may be clearly seen.

In recording the time signals are received and forwarded, fractional parts of a minute less than half-a-minute must not be counted, and the half-minute and fractional parts more than half-a-minute must be reckoned as a minute, thus :— 15¼ must be entered as 15 minutes only, and 15½ minutes as 16 minutes.

27. *Testing Block Indicators and Bells.*—This signal must be used to ascer-

tain whether the bells and instruments are in perfect order, and only when no train has been signalled. Where the bell instrument is separate, the bell testing signal must precede the block instrument testing signal.

28. *Time Signal.*—Signal-men receiving this signal on the speaking instruments at 10 A. M. must communicate the information to the signal boxes which do not receive it on the speaking instruments, by giving the "time" signal on the bell. Signal-men must regulate their clocks accordingly.

29. *Lampman or Fog Signal-man Required.*—At boxes where a lampman or fog signal-man cannot be communicated with by the signal-man on duty, the signal "lampman or fog-signal-man required" must be given to the box where the man required can be communicated with. The signal-man receiving such signal must at once inform the station master or person in charge, in order that the necessary assistance may be given.

30. *Testing Slotted Signals.*—Signals which are slotted from another signal box must be tested as soon after the signal-men change duty as the running of the trains will permit. The signal-man in charge of the slotted signal, after releasing the lever so far as he is concerned, must give 20 beats on the bell (thus: 5—5—

5—5) to the signal-man at the signal box from which the signal is slotted. This must be repeated, and the signal lever worked three times slowly. Each signal-man must make an entry of the transaction in his train register book, and if the wire working the slot requires adjusting, the signal-man going off duty must walk to the other signal box and see it put right, unless he can get this done by sending a message on the speaking instrument or otherwise. Slotted signals must not be tested after the "is line clear" signal has been received for a train on the line to which they refer.

31. *Parallel Lines.*—With reference to rules 12, 17, 19, 20, 22 and 23, where there are parallel running lines, the necessary steps must be taken to stop or caution the trains running on any lines that may possibly be obstructed by what has occurred.

32. *Mixed Trains* conveying passengers and goods must be signalled and dealt with as passenger trains.

33. *Public Level Crossings.*—Traction or other heavy engines, heavy loads of timber, &c., or droves of animals must not be allowed to pass over level crossings at block signal boxes after permission has been given for a train to approach from

the signal box in the rear, nor until the line has first been blocked in both directions in accordance with Rule 13. The "is line clear" signal must not be accepted after permission has been given for a traction or other heavy engine, a heavy load of timber, etc., or a drove of animals to cross until it is clear of the line.

34. *Working of Signals Through Short Sections.* — Where the sections are short, and where mechanical disks exist in the signal boxes, the signals at the box in the rear must not be lowered until the disk from the box in advance has been turned up, signifying "line clear" or "distant off." When the "is line clear" signal has been accepted by the box in advance, but the disk remains turned down ("danger"), any approaching train must, by the exhibition of both home and distant signals, be brought thoroughly under control before the home signal is lowered to allow the train to proceed. Any modification of this rule to be notified at the foot of the block card by the district superintendent.

35. *Working of Outdoor Signals.*—It is very important that the signal-men should watch closely the working of the home, starting and distant signals, in order to ascertain that the signals go back to "danger" in all cases in response to the levers. The back light at night, or, if the actual signal is not visible, then the

electric repeater, should systematically be watched in connection with each operation, to make certain of the proper action of the signal arm.

Should an electric repeater be out of order, permission must not be given for a train to approach from the signal box in rear unless "train out of section" has been received for the previous train from the box in advance.

If a signal-man becomes aware that any signal, other than a starting or advanced starting signal, worked from his box is defective, so that the "danger" signal cannot be exhibited, he must advise the signal-man at the box in the rear, and the latter must stop all trains proceeding in the direction of the defective signal, and advise the drivers of the circumstances.

At boxes where there is no speaking communication the signal-man at the box from which a defective signal is worked must not accept the "is line clear" signal from the box in rear until it has been sent to and accepted by the box in advance.

36. *Engineers' Specials.*—The engineers' engines are supplied with a special round target, to be placed in front of the engine when intended to make a long run without stopping. The signal-man must signal as "express passenger" any engine carrying this target. The target must be taken off at the signal box in rear of any

section in which it is intended to stop. The driver must stop at that box and tell the signal-man that a stop will be made in the section, and the engine and carriage must then be signalled forward in the same way as a "ballast train requiring to stop in section" (see Rule 8). Engineers' carriages may be propelled on the main lines.

The block telegraph signals for the engineers' specials must be recorded in the train register book with the remark "engineers' special" added in each case.

37. *Accident to Trains, &c.—Notice to be Given.*—In case of accident to trains, or of the line being blocked by vehicles off the rails at or near to signal boxes, the signal-man must, in all cases, not only give the "obstruction danger" signal to the next adjacent box or boxes, as laid down in clause 12, but also communicate by speaking instrument or by messenger to the nearest telegraph station, apprising the station master or signal-man there of the obstruction, so that he may take steps to advise drivers of approaching trains of the occurrence, either by stopping them out of course, or by telegraphing to the previous stopping station, in order that the station-master there may give them the needful warning.

38. *Engine Brought to Rear of a Train to Attach or Detach Vehicles.*—When-

ever it is necessary, at stations where absolute block working is in force, for an engine to be brought to the rear of a train for the purpose of attaching or detaching a vehicle, the operation must only be carried out under the personal supervision of the station master or person in charge.

The "warning arrangement" of the London & North Western Railway (Rule 5) is for use in sending a train to a junction or other point where another train is obstructing the main track, as when two trains are to be combined, or when two trains are to exchange passengers, etc., at a junction. The general use of this rule is not recommended. It is suggested that when it is deemed advisable to use this arrangement, both the conductor and engine-man of the following train should be given a written notice stating the condition of affairs at the block station ahead. Trainmen should be instructed that a train running under the warning arrangement must be under absolute control by the time it arrives at the distant signal. In operating under this rule extraordinary care is required in approaching, on descending grades, block stations where the main track is obstructed.

RULES OF THE ERIE RAILROAD (ERIE DIVISION) FOR OPERATING THE BLOCK SYSTEM.

The signal equipment of the Erie Railroad proper (Erie Division) consists of the controlled manual (Sykes) system for part of the way and the manual system for the rest of the way. In both cases the out-door signals are of the ordinary semaphore type and consist of a distant and a home signal for each track at stations where there are main tracks only, and of distant, home and advance signals where there are cross-overs. Side track block signals, interlocked with the main track block signals, are also provided for controlling movements from sidings and over main track cross-overs.

At railroad crossings and junctions, ends of yards and important passing sidings, the block signals are so interlocked with the switches and switch signals that

a clear block signal cannot be given when an intervening switch is set for a contradictory movement, or when another train is fouling the junction.

At important points where the distant signals are placed out of sight of the signal-men operating them, signal indicators similar to the one described on page 30 are used.

At railroad crossings, junctions, draw-bridges and other such dangerous points, the main tracks and all the tracks that foul the main tracks are provided with derails interlocked with the block signals.

RULES.

Two signals of the semaphore pattern are placed at each block station, governing east and west bound trains respectively. When both of these signals are mounted upon the same post, trains will be governed by the arm extending to the right of the post as viewed from approaching trains. When the signals are mounted on separate posts, trains will be governed by the signal at the right of the main track or tracks as viewed from approaching trains.

A block is the portion of track lying between two block stations; and each block will be operated independently for east and west bound trains.

1. Trains running by block signal rules are governed absolutely by fixed signals at the block stations, and will not observe train rules 87, 88 and 89 ("time limit" rules).

2. Trains are governed during the day by the position of the signal arm, and at night by the light on the top of the signal post.

When the signal has its arm extended horizontally, or displays a red light, it denotes danger; a train is in the block in advance and the following train shall stop.

When the signal has its arm in an inclined position, or displays a white light, it indicates that the block is clear, and is authority to proceed.

3. A signal must always display red, except when changed to white to allow a train to pass; and as soon as the whole of a train has passed a signal it shall be returned to red.

4. When a train approaches a block station, white shall be displayed, if a train is not in the block in advance.

5. When it is necessary to allow more than one train in a block the signal-man shall display by hand a green signal in addition to the block signal. The green signal authorizes a train to pass the advance or block signal, and proceed cautiously to the next block, with the knowledge that another train is occupying the block. Signal-men shall not display a green signal without an order from the train dispatcher, except as provided in bell code.

6. If a train arrives at a block station when the signal-man is absent, or disabled, or where the signal is not working and orders cannot be obtained, the train shall proceed as though green were displayed.

In the absence of a signal at a block station trains shall stop, and the cause must be ascertained.

If an operator is on duty and cannot get orders for the train, he must give written notice to the conductor of the reason for not displaying the proper signals.

7. If the telegraph line or signal bell fails to work after a train enters a block, and the signal-man cannot ascertain that the block is clear for an approaching train, or cannot get permission to display green, it shall be stopped and the conductor and engine-man notified in writing by the signal-man. The train may then

proceed as though green were displayed, 10 minutes after the departure of the next preceding train.

8. If the white signal is not displayed, a train approaching a block station shall run so that it can be stopped before the engine passes the signal.

When a passenger train is stopped by the block signal at a station where it receives or discharges passengers, it may run to the station platform, and if the block signal cannot be seen by the engine-man, the conductor shall personally direct him to proceed after the proper signal is displayed.

9. A train shall not be backed after passing a block signal. If from any cause the engine has passed the signal, without the signal to proceed having been displayed, the conductor shall personally direct the engine-man to proceed, after the proper signal is displayed.

10. The conductor of a train taking siding (to be met or passed by other trains) must immediately report to the signal-man at the tower at the station at which he takes siding as soon as his entire train is clear of the main track.

11. When it is necessary for a train to cross over on to the opposite track, the conductor, before crossing, shall notify the signal-man at the block station nearest

the cross-over to be used. The signal-man shall then notify the signal-man at the next block station in the direction in which the train is moving, and the train shall not cross over until the conductor is notified that the signal-man at the block station in advance has been notified, and a flagman sent out. * * * When the signal-man in the advance station is notified, he shall stop any train approaching on the opposite track, and notify the conductor and engine-man in writing that the train has crossed over. He may then allow it to proceed under a green signal. If a train is in the block on the track to which the train is to cross, the signal-man shall not permit this train to cross over until the other has arrived at his station.

When a train pulls or backs out of a siding or crosses back to its own track, before doing so the conductor shall notify the signal-man at the block station nearest the switches to be used. The signal-man shall then notify the signal-man at the next block station in the rear, and the train shall not pull or back out or cross over until the conductor is notified that the signal-man has been advised. When the signal-man in the rear block has been so notified, he shall stop any train approaching on the track obstructed, and hold it until the block is clear. If a train is in the block on the track to which the train is to pull or back out or cross back on, the signal-

man shall not permit the train to pull or back out or cross over until the train has arrived at his station.

12. At starting and junction points a train shall not go on to the main track until a signal to proceed has been given, and this shall not be given until the train has been protected on the track it is to enter upon or cross; this must be done by notice to the block stations in the proper directions and by use of signals as required in the rules, or by fixed signals.

13. When from any cause it is necessary to couple two or more trains together to be run as one, they shall not be separated under any circumstance until the train arrives at a block station. If they are then separated, each train shall be governed thereafter as a single train.

14. On a double track, if one is obstructed, the same advance or block signals shall govern trains using the left-hand track that would govern if they were on the right-hand track.

15. Every train, while running, must display two green flags by day and two green lights by night, one on each side of the rear of the train, as markers, to indicate to the signal man that the entire train has passed the station.

16. When a train passing a block station has no markers, the signal-man shall notify the signal-man at the block station on each side of him in the prescribed form, and the signal-man at the station in advance shall stop the train, and ascertain why markers are not displayed. The signal-man at the rear station shall consider the block obstructed until notified in the prescribed form that it is clear.

17. Signal-men should closely observe each train as it passes their station, and if anything about it is noticed wrong, such as a swinging car door, brake beam, or anything else hanging, which looks to be dangerous, they shall notify the block station in advance in the prescribed form. The signal-man in the advance station shall stop the train and notify train-men of the dangerous condition of their train.

18. An operator having orders for a train shall display a red signal in addition to the block signal.

19. In displaying green signals under these rules, the signal-men shall use a green flag by day or green lamp by night, and shall hold the signal with the hand outside of the signal-house window and in full view of trainmen. When the signal is not in use it must be kept out of sight of approaching trains.

If the blocks in both directions are not clear or are obstructed when two or

more trains are approaching a block station at about the same time, and the signal-man has occasion to give the green signal to only one of them, but cannot do it without the other trainmen seeing the green signal, they shall all be stopped and the trainmen of the train that is to proceed under the green signal properly notified.

In displaying red signals for train orders at the block stations, a red flag by day or red lamp by night shall be used outside of the signal-house window in full view of trainmen, except where fixed train-order signals are erected.

Flags must be kept clean, and must be renewed when their color becomes indistinct.

20. When trains are delayed, from any cause, at stations, or in a block, a flagman shall be sent back to protect the train, as though it were not protected by block signals.

21. A train shall not pass a block station when red is displayed, except under the conditions herein provided.

22. Night signals shall be displayed from one hour before sunset until one

hour after sunrise, and when, by reason of storms, fog, or other causes, the day signals cannot be clearly seen.

Operators shall promptly report to the train dispatcher the condition of the weather in case of fog or storm.

23. The rules governing the use of block signals do not relieve trainmen from observing all other rules relating to the protection of trains.

24. Signal-men shall promptly report to the next block station, in each direction, the movement of trains passing their stations by means of the prescribed code.

25. Signal-men shall be governed by the following bell code:

BELL CODE.

1. Acknowledgment of any signal except as herein provided.
2. All right? Yes.
3. Unlock my lever (Sykes system). Answer by plunge, 5 or 3–1. Is block clear? Answer by 2 or 5.
4. Train has entered block.
5. Block not clear. Or, block obstructed.

6. Is there a train coming to me?

2–1. No.

2–4. Has train cleared? Answer by 4–2 or 5.

3–1. Have plunged (Sykes system). If you are not unlocked, allow train to proceed under green. Repeat 3–1 to sender.

3–3. Train is on siding clear of main track. Allow train to come in block under clear signal.

3–3–3. Train to you broken in two. Answer by repeating 3-3-3 to sender.

2–3–2. Signal just received, not understood. Please repeat.

4–2. Train has cleared.

4–4. Train is going on side track.

2–2–2. Error signal. Repeat to sender.

6–4. Testing signals. Repeat to sender.

9. Stop train. Has no markers.

3–2. Train from you passed without markers.

5–5. Train has crossed over on to opposite track. Repeat to sender.

2–5. Stop and examine train.

3-5. Train is returning to its own track.

4-1. Train has left preceding passing track (to be used only on single track).

RULES FOR WORKING BELL CODE.

No. i. 1. Acknowledgment for any signal except as herein provided.

No. ii. 2. All right. Yes.

No. iii. 3. Unlock my lever (Sykes system). Is block clear? Give to signal-man in advance block station as soon as you receive 4 from signal-man in rear block station.

No. iv. 4. Train has entered block. Give to signal-man in advance station as soon as first portion of train passes the signal governing that block.

No. v. 5. Block not clear. This signal will also be used to notify signal-men in both directions in case of accident or obstructions of any kind. Signal-men receiving this signal will hold all trains until notified that the block is clear. (See page 151).

No. vi. 6. Is there a train coming to me?

No. vii. 2-1. No.

No. viii. 2–4. (Has train cleared yet?) To be given when you have not received clear for a train that has entered the block which you think has had time to clear. In case the reply is 4–2, give 3 and receive 2, or plunge before allowing train to proceed.

No. ix. 3–1. (Have plunged. [Sykes system]. If you are not unlocked, allow train to proceed under green), announcing by 4. This must be given only when you find by plunging you do not release the signal in the rear, and are certain that the last train that you plunged for has passed. Repeat 3–1 to sender.

No. x. 3–3. (Train is on siding clear of main tracks. Allow train to come under clear signal). To be given to signal-man in rear when a train has taken siding and you are positive it is clear of main tracks, and switches closed.

No. xi. 3–3–3. (Train to you broken in two). Signal-men receiving this signal will use every effort to notify trainmen that they are broken in two, and to prevent the detached portions from coming together. If block ahead is not clear, allow the head end to go on green signal, giving them an additional signal * * * * that they are broken in two.

No. xii. 4–2. (Train has cleared). Give to signal-man in rear station as

soon as the train bearing markers has cleared and your signal is thrown to danger in rear of train.

No. xiii. 4–4. (Train is going on side track.)

No. xiv. 2–2–2. (Error signal.) To be given when you have given a signal in error, and must be repeated to sender.

No. xv. 6–4. (Testing signal.) Must be repeated to sender until acknowledged by 1.

No. xvi. 9. (Stop train and notify them of absence of rear signals.)

No. xvii. 3–2. (Train from you passed without markers.) To be given to station in rear, who must hold following train until clear has been given.

No. xviii. 5–5. (Train has crossed, or is going to cross over on opposite track.) This signal must be given to signal-man in direction in which the train is going to cross over, who will stop any train approaching in opposite direction, and notify the conductor and engine-man in writing that a train has crossed over. He may then allow it to proceed under green (see page 152).*

* When trains cross over at interlocking points and are protected by distant and home signals, this rule will not apply.

No. xix. 2–5. (Stop and examine train.) Signal-men receiving this signal shall stop the train and notify trainmen. When signal-men are operators, they shall notify the advance station by telegraph what they noticed wrong about the train.

No. xx. 3–5. Train is returning to its own track after having backed over or is taking main track from siding. This signal to be given signal-man in the direction from which trains are approaching, who will hold any train until notified that track is clear for approaching trains by 4–2. If the train which is taking main track from siding will foul both main tracks, this signal will be given to signal-men in both directions. Signal-men in both directions will hold trains as provided above*

No. xxi. 4–1. (Train has left preceding passing track.) Signal-man at first advance block from a passing siding receiving signal 4 will give the signal 4–1 to signal-man in advance block, to be repeated through intermediate blocks to signal-man at passing siding in advance. Signal-man at passing siding receiving the sig-

*When trains are returning to their own tracks at interlocking points and are protected by distant and home signals, this rule will not apply.

nal, viz.: 4–1, will not allow any train to leave his station until the train or trains for which he has received this signal have arrived at his station.

No. xxii. Operators must bear in mind that in order to give distinct signals the key must be pressed down firmly; short, quick taps on the key give imperfect signals.

No. xxiii. Care must be taken to keep the contact points of the key clean. Dirty points make bad connections, and are liable to prevent the ringing of the bell.

SYKES APPARATUS.

No. xxiv. Never plunge unless asked to do so, and also never ask to be released until train has been rung to you."

Signal-men must be prepared to act promptly upon receipt of bell signal 5, the "obstruction danger signal," (see Erie Railroad Rules, page 147), as upon the prompt handling of this signal may depend the safety of a train. If this signal is received after the out-door signals have been placed at "safety" for an approaching train, they must be returned to "danger" as quickly as possible. Should a train be pass-

ing at the time every effort must be made to stop it. Auxiliary danger signals consisting of a red flag for use by day and a red light by night, and at least six torpedoes (detonators), all in condition for immediate use, must be kept at each block station. *One* torpedo must be placed on the obstructed track, on the engine-man's side, as soon as the signal 5 is received, and must not be removed until the signal is cancelled.

When a signal-man receives bell signal 5–5 he may allow a train to proceed cautiously to the block station from which the signal is received, after notifying the conductor and engine-man in writing that a train has crossed over to their track. A train must not pass to the opposite track until the bell signal 5–5 has been sent and acknowledged as prescribed, nor until the arrival of any train that may be approaching on that track. A train that is occupying the opposite track should be within cover of the home signal, so that an approaching train can run up to the signal. A safe rule for the engine-man of an approaching train to follow, in making this move, is to run under such control as to be able to stop at the distant signal, if necessary. On heavy down grades the 5–5 signal should not be used.

MOZIER SYSTEM.

On the New York, Pennsylvania & Ohio line of the Erie Railroad (Ohio Division), the Mozier system of blocking is used. This system differs from the ordinary manual blocking in that the passage of a train into a block is controlled by the train dispatcher, no train being allowed to enter a block without his permission. When a train enters a block the dispatcher is notified of the fact by wire, and he then directs the signal-man at the station in advance of the train what signal to display to the train on its arrival there. The out-door signals used in this system are of the semaphore type, and can be placed in three positions—the ordinary "clear" and "danger" positions, and a "cautionary" position in which the signal inclines about 45° *above* the horizontal.

A METHOD OF SINGLE TRACK BLOCKING.

While single track blocking must govern both the non-meeting and the non-following movements, its main object is to control the non-meeting (head-to-head)

movements, which are the more important. To accomplish this it should provide for holding a train at a passing siding while another train moving in the opposite direction is approaching that point.

There are two principles in single track blocking which should always be kept in mind. First, all meeting and passing points must be at block stations. Second, for the non-meeting movements that section of the line between the passing sidings must be operated *as one block*, regardless of intermediate block stations.

Where the distance between passing sidings is considerable it may be necessary to put in intermediate block stations for governing the non-following movements if the traffic is heavy. The necessary bell signalling from one passing point to another can be done expeditiously by means of a separate wire and bells con-

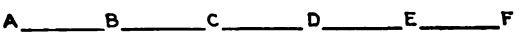


DIAGRAM NO. 1.

necting these stations only. This is shown in the diagram No. 1. The passing sidings are at A and F, and there are intermediate block stations at B, C, D and

E. All the block stations are connected by wires, as shown by the shorter lines, while a separate wire connects the stations at the passing sidings, as shown by the longer line. This wire should be used in signalling for the non-meeting movements only, the bell wire from station to station being used for the non-following movements, as in double track blocking. The separate wire can be dispensed with, however, by repeating the A—F signals through the intermediate stations.

When a train is to take the siding, the block station at the siding should be notified of the fact in advance, so that means may be taken to prevent delays to opposing trains. The train should communicate its intention to the block station in the rear of the passing siding by a pre-arranged whistle signal or by a written notice signed by the conductor. The signal-man, after ringing in the train ("train has entered block") to the signal-man at the siding, should impart to him the additional information given by the train.

The following additional bell notifications are required in this method:

Hold all trains coming to me. ("Hold" signal.)

No train going to you.

Cancel "hold" signal.

Train to you from passing siding.

Train from you clear.

Train last rung in takes siding.

The mode of operating head-to-head movements under this method is as follows :

Prior to starting a train from the passing siding at block station A, (see Diagram No. 2) the signal-man there calls the signal-man at block station D, at the

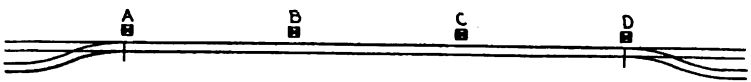


DIAGRAM NO. 2.

next passing siding ahead, by one stroke of the bell ("attention"), which signal is acknowledged by D. A then gives to D the signal "Is there a train coming to me?" If there is no train moving from D to A the signal "No train going to you" is given by D and acknowledged by A. A thon signals to D, "Hold all trains coming to me." D acknowledges this signal and is governed by it until he receives

from A the signal "Cancel hold signal." As soon as the head end of the train enters the block, A signals to D, "Train to you from passing siding," which signal D acknowledges. The "hold" signal should not be kept in force by A when there is no train in the block, but should be cancelled as soon as the signal "Train from you clear" is received from D for the last train sent by A. As soon as the train, with markers, has passed D, the signal "Train from you clear" must be given to A.

It is suggested that separate ringing-in notifications be used for passenger and freight trains, as follows:

Passenger train has entered block.

Freight train has entered block.

It is fair to presume that the ringing-in as such of passenger trains—on most lines the less frequent but always the more important movements—will naturally cause the signal-man to be especially on the alert for these trains.

As a further precaution, each signal-man should, as soon as he has placed his signals in the "danger" position after the passage of a train, notify the signal-man at the station in advance that he has so placed his signals. If the signal-man in the advance station does not receive this notification promptly after receiving the

signal "train has entered block," it will be his duty to ask for it. This will necessitate the use of two more bell notifications, as follows:

My signals have been placed in the "danger" position.

Are your signals in the "danger" position?

For single track blocking the "lap" siding seems to be the best arrangement for a passing siding. The lap siding is an arrangement of passing tracks on a single track line, whereby double track is provided at meeting points, with the switches so arranged that trains moving in opposite directions cannot interfere with each other at the passing point, as shown in Diagram No. 3. For example, two trains are to pass each other and to be passed by a third train. Both of the two first mentioned trains take their respective sidings, one at A and the other at B, and wait until passed by the third train. Then, in proceeding, neither train obstructs the other, as the eastbound train moves to the right and the westbound train to the left in order to regain the main track, and turnouts for their respective sidings are separated by a short stretch of the main track. In operating lap sidings greater safety may be secured at head-to-head meeting points by making both trains take their respective sidings even when a third train is not included in the

movement. This will prevent any misunderstanding at an irregular meeting point as to which train should take the siding, and will cause no serious delay, as, properly, trains always come to a full stop at meeting points.

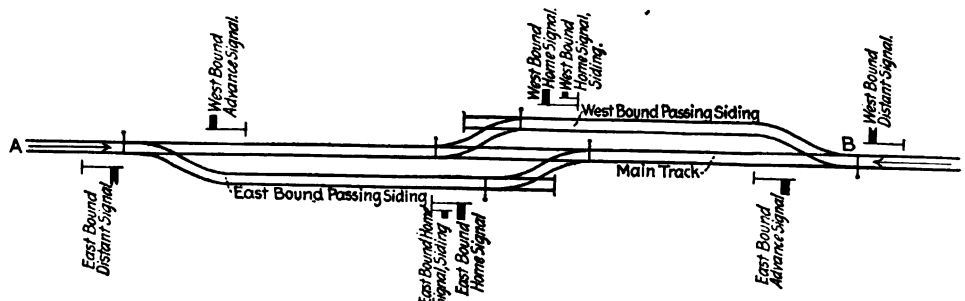


DIAGRAM NO. 3. LAP SIDING.

A train using a "lap" siding at a meeting point should enter the siding at the far end, and the train to be met, if it is to keep the main track, should be held

at the home signal until the arrival of the other train on the siding. By this arrangement the two trains are kept a safe distance apart while the passing is being accomplished. Safety switches placed at the clearance point of the station ends of passing sidings and working in connection with the main track switches will form an additional safeguard against trains in opposite directions fouling at passing points.

At meeting points on single track, when two trains are approaching in opposite directions, the home signal must be kept at "danger" until both trains are brought to a full stop, and the signal must not be given to either train until the signal-man knows that the track is clear for the required movement.

OPERATING OUTLYING SWITCHES.

The New York, New Haven & Hartford Railroad, on its New York Division, has the following instructions in regard to a train or an engine taking an outlying siding:

"Engine-men of trains that are to take an outlying siding in any block will so notify the operator at the rear tower by six low, short, blasts of the whistle, given thus: - - - - - -.

"Tower-men receiving this signal must give 3-3 to the advance tower, which must be answered by repeating.

"A train or engine having taken an outlying siding, clear of the main line, and all switches being set and locked for the safe passage of trains on the main track, the conductor will give the following signal from the switch-house: 1-2-3 (6 beats, given thus: 1, short pause; 2, short pause; 3).

"This signal must be repeated until it is answered by the same signal given from the tower in the rear.

"When ready to leave siding the conductor will give the following signal: 3-4 (7 beats, given thus: 3, short pause; 4.)

"This signal must be repeated from the tower before the switch is unlocked or main track obstructed. If the acknowledgment (3–4) is received, the train may leave the siding, but must be protected by flagman while so doing. If signal 3–4 is answered by 5 beats of the bell, it will signify that the block is not clear and train must remain on siding until the signal 3–4 is received from the tower.

"In case of failure of the bell signals, the train on siding may cautiously follow a preceding train ten (10) minutes after its passage, provided it can clear the

schedule time of all trains of superior rights at least ten (10) minutes, and that it is protected as required by the rules, before obstructing the main track and until it has passed the next tower.

"Conductors must attend to signalling from switches in person and will be held responsible for the strict observance of the above rules.

"A tower-man receiving the signal 3–4 will first ascertain whether the block ahead is clear, and, if so, and there is no other train approaching having superior rights, he will give the signal 3–4 and allow the train on siding to proceed. If his signals have been unlocked for a following train, or if there should be any other reason why the train should not leave the siding, the signal 5 should be given instead. When a tower-man has permitted a train to pass from an outlying siding to the main track, he must immediately announce it to the advance towerman and both must take all necessary precautions not to admit another train to the block until the train from the siding has passed the advance tower."

CHAPTER XI.

CONTROLLED MANUAL BLOCKING.

In controlled manual blocking the manipulation of the out-door signals at the entrance to a block is controlled, electrically, by the signal-man at the block station in advance. In what is sometimes termed the auto-manual system there is at each block station a track circuit of at least two or three rail lengths, which is used in actuating an "electric slot" (see page 165), for automatically replacing the home signal to "danger" when the rear end of a train passes that signal.

The locking instruments are generally placed in front of the signal-man and over the levers with which they operate. Each block station has one of these instruments for each block, the two instruments at the opposite ends of a block

being connected by an electric circuit. The code signalling between the stations is accomplished by bell, as in manual blocking.

To illustrate in general terms the manipulation of the signals in the controlled system we will assume there are two block stations, A and B, each provided with the ordinary out-door signals interlocked with the electric apparatus. Prior to starting a train from A the signal-man there asks B to unlock his signal, and when B does so A throws his signal to "safety," allowing the train to proceed toward B. As the rear of the train passes the home signal at A that signal is thrown to "danger" by the train passing over the track circuit. As soon as his home signal goes to "danger" A throws his lever to its normal position, ("danger") thereby locking it so that the signal cannot be thrown to "safety" again without permission from B. A drop slide indicator, or annunciator, forms a part of the electric mechanism, displaying through a slotted opening on the front of the instrument case the formulas "free," "locked," and "train in block," or words to that effect, as required. By a system of electric locking, working in connection with the indicators and operated in part by the train through track circuits, B is unable to clear A while there is a train in the block. Normally the indicator displays "locked," but when

the signal is unlocked the word "free" appears on the indicator. When the unlocked signal lever is placed in its clear position the indicator is returned to its normal position, displaying "locked." The block signal is not, however, actually locked until it is returned to "danger."

The "Sykes," the "Patenall" and the "Union" are among the principal lock and block instruments used in this country. In the Sykes and Union instruments the signal operating levers are normally locked, except when unlocked by the signalman at the station in advance, while in the Patenall instrument the signals are locked only when the line is blocked by a train, thereby leaving them free to be thrown to either "danger" or "safety," as may be desired, when the line is clear. In the Union instrument the electrical apparatus and the levers are connected electrically; in the Sykes and the Patenall instruments they are connected mechanically.

The "electric slot" is an appliance for automatically cutting out the block signal from its actuating lever, and is used to automatically return the signal to "danger" behind a train. It is actuated by a track circuit, as heretofore mentioned, placed ahead of the signal, and forms a removable connection

between the signal counterweight and the signal rod, which connection, if removed when the signal is in the "clear" position, permits the signal to return to "danger" by force of gravity. The signal cannot again be placed at "safety" until the signal lever has been placed in its normal ("danger") position. This device therefore prevents a signal-man, after having allowed a train to enter a block, from carelessly leaving his signal at "clear," to be accepted by a following train, or from carelessly and prematurely releasing the signal at the rear station while a train is in the block.

The electric slot may also be used as the controlling instrument in a controlled blocking system not having electric locking instruments. In this case the slot is operated from the signal station in advance, the connection being normally cut out. When the signal-man at the station in rear asks and is given permission to forward a train, the signal-man in advance cuts in the signal connection so that the signal can be put to "clear." When the train enters the block the home signal is thrown to "danger" behind the train, and it is kept at "danger" while the train is in the block, by means of a track circuit, which keeps the connection cut out so long as there is a train or any portion of a train in the block. There-

fore, neither signal-man has it in his power to give another train a "clear" signal while the block is obstructed by a train.

With the controlled system the following points require particular attention:

To ensure having the home signal kept at "clear" during the entire time that a train is passing it, as required, the local track circuit that operates in throwing that signal to danger behind a train must be placed a maximum train length ahead of the signal. If very long trains are handled, as on American coal roads, where a train often has from 80 to 100 cars, (say 2700 to 3400 feet) the circuit should reach at least five-eighths of a mile in advance of the home signal.

To effectually guard against the unlocking of the signals in the rear when the head portion of a parted train has passed the advance station and left the rear portion in the block, a track circuit, extending throughout the block, as in automatic blocking (page 183) should be used, to connect the locking instruments at one end of the block with the electric locks at the other end; otherwise, the passage of the train into the block in advance would enable the signal-man to unlock the signals at the rear station, while the block was obstructed by the rear portion of the preceding train.

At stations where there are cross-overs, the cross-over switch points should be

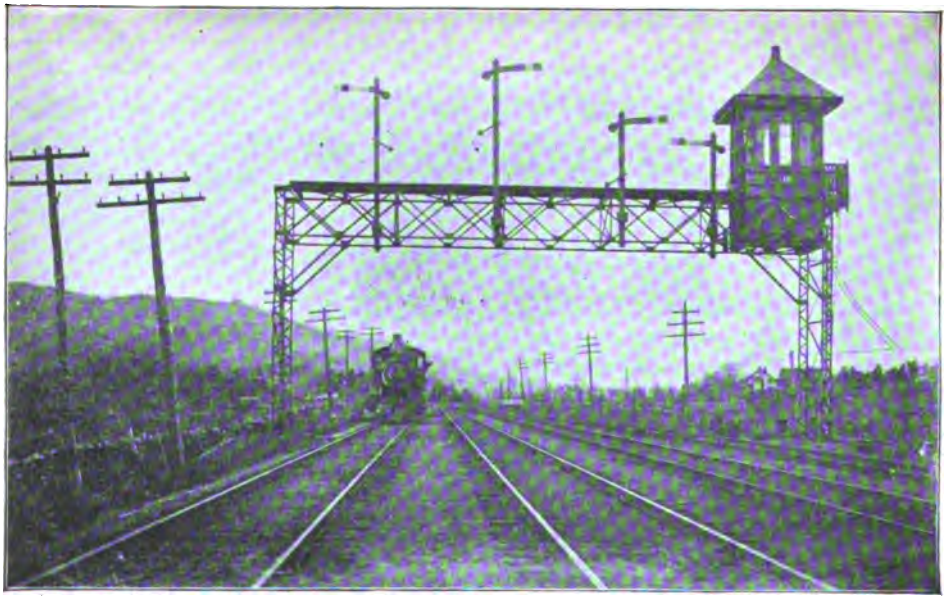
electrically connected with the locking instruments governing the movements in both directions, the circuits being so arranged that both instruments will be locked while a cross-over switch point is set for the side movement, or either main track is fouled, and that the instrument governing a track will be automatically released as soon as the train is clear of that track and the switches are set for the main track movement.

Great care must be taken by the signal-man at a station where switching is done on the main track, or where a main track can be otherwise fouled, to see that the track is clear before a train is accepted for it, especially if the locking instrument at that station, and which controls the signals at the rear station, is not automatically interlocked with the switches. In the case of switching, the signal-man must not accept a train until he is notified by those in charge of the switching that the main track is clear of cars, and that the switches are set for the main track movement. This applies to all forms of blocking.

All main track switches at a block station should be so interlocked (electrically) with the signal locking instruments that when a train on a siding fouls the main track, or a switch is set for a side movement, the signal-man there cannot give

permission to the station in the rear to let a train come forward. Or, in other words, at a station where there are sidings, cross-overs, junctions, etc., and especially if switching and the making up of trains is done on the main track, the signal locking instruments at the station should be electrically controlled by a track circuit embracing the main track at all points where it can be occupied by trains or cars, or fouled by trains on sidings, or broken.

As a general proposition, the controlled system may be summed up thus: To ensure absolute safety for the main track in a block, including the territory for at least 1,000 feet ahead of the home signal at the station in advance (or a greater distance on a down grade), the main track switches at such advance station (including those within the 1,000-foot limit), and all outlying switches in the block, must be electrically interlocked with the block station in the rear, so that the signals at the station in the rear, which control the entrance to the block, cannot be placed at "clear" when the main track is occupied, or is fouled by a train on a side track, or when a main track switch is thrown for a side movement, or a main track "back up" signal is set for a backward movement. This system applies only to the operation of trains under the *absolute* block system.



METHOD OF ARRANGING HOME SIGNALS AND BLOCK TOWER ON THE FOUR-TRACK LINE OF THE NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

New York Central and Hudson River Railroad Company's Rules for Operating Controlled Manual Blocking on its Four Track Line.

The signal equipment of the New York Central & Hudson River Railroad consists of the ordinary out-door signals, as noted in the operating rules of that company, interlocked with signal-controlling lock and block instruments, as described on pages 163 and 164.

RULES.

A block is a portion of track lying between two block towers, and each block will be operated independently for passenger and freight tracks, and for east and west bound trains.

All signals are of the semaphore pattern with arms extending to the right of the post, as viewed from approaching trains. They are divided into four classes, namely: advance, home, distant and dwarf signals. Where signals are on bridges, those for passenger tracks have been made higher than those for freight tracks. Posts are placed over the tracks which they govern, except as stated in general notices and their accompanying blue prints. (The arrangement of signals on bridges is shown in the figure on the opposite page.)

At block towers where there is no interlocking, there is a one-arm post for each main track, located on the bridge directly over the track which it governs.

At block towers where there are switches controlled by interlocking, there are located a distant, a home and an advance signal for each main track.

At all points where there are facing switches in main track, home signals are provided with two arms; the top arm governing the main or high speed track, and the lower arm all diverging tracks.

Where the signals for tracks Nos. 2 and 3 are not on a bridge, a bracket post is used. Where signals for both tracks Nos. 2 and 3 are on a bracket post, the one for track No. 2 is made the higher. When only one arm is used it is for track No. 2.

At all interlockings, and at all block towers where the view of the home signal is obscured, a distant signal will be provided for each main track, located not less than 1,600 feet from the home signal.

On the home and starting signals (which are painted red, with a white block near the end) the arm in a horizontal position by day, or a red light at night, means 'danger (stop).' The arm lowered to a nearly vertical position by day, or a white light shown at night, means 'all clear,' and is authority to proceed to the next signal.

On the distant signals (which have a forked end, and are painted yellow with a black < shaped band near end of blade) the arm in a horizontal position by day, or a green light at night, means 'caution (proceed to the next signal with train under full control).' The arm lowered to a nearly vertical position by day or a white light shown at night means home and starting signals are clear.

Dwarf signals govern movements over all switches in reverse direction of traffic and from sidings to the other tracks. The arm in a horizontal position by day, or a blue light at night, means 'danger (stop).' The arm lowered to a nearly vertical position, or a white light shown at night, means 'all clear,' and is authority to proceed.

1. Trains running by block signal rules will be governed absolutely by the fixed signals herein described and will not observe train rules 86, 87 and 88 ("time limit" rules). Trains will be governed during the day by the signal arms and by night by the lights on the posts.

2. All signals must be kept in their normal condition ("danger" or "caution"), except when lowered to allow train to pass, and must be restored to normal position as soon as whole train has passed.

3. If a signal-man becomes disabled or is absent from his post, and it is ascertained by the conductor and engine-man, the train must proceed cautiously to the next block, the same as though a caution card had been given.

4. If the telegraph wire or signal bells fail to work, and the signal-man cannot ascertain if the block ahead is clear, the train should be stopped and the conductor and engine-man given a caution card.

5. Should a train be stopped by signal in consequence of a disabled train being in the block ahead, the signal-man will give the conductor and engine-man a caution card, authorizing them to proceed to the point of obstruction. They will then proceed with caution into the block so occupied and render any assistance necessary to move the disabled train and clear the block.

6. In case of failure to get unlocked, after receiving notice from the signal-man in advance that the block is clear and he has plunged to unlock, and acknowledging the same, the signal-man should give the conductor and engine-man a clearance card, authorizing them to proceed to next tower.

7. In case of trains passing towers without markers * * * the signal-man must notify towers in rear and advance, as provided in bell code. The signal-man

in advance tower must clear his signals, provided the block in advance is clear, and display a green and white signal, which is a notification to the approaching engine-man that his train has parted. The rear signal-man will, in this case, stop the following train, and give the conductor and engine-man a caution card, showing that the preceding train has parted, and that the rear portion will, probably, be found in the block. * * * *

8. Work trains when occupying the main track to do work must inform the signal-man at the last tower passed of their purpose and leave a flagman at said tower. The signal-man must then forward the following train on a caution card marked " work train in block."

9. When the signal 5–4, showing obstructions, has been received, the signal-man shall give conductor and engine-man a caution card and allow them to proceed ten minutes after departure of preceding train.

10. When it is necessary for a train to cross over to the opposite track, the conductor, before crossing, must notify the signal-man at the block tower before reaching the cross-over to be used. The signal-man must then notify the signal-man at the next block in the direction in which the train is moving, and the train

shall not cross until the conductor is notified that the signal-man at the block tower in advance has been notified and has answered by the "all-right" signal, and flagman sent out. * * * * The signal-man in the advance tower, after receiving such notification, must stop any train approaching on the opposite track and give the conductor and engine-man a caution card, notifying them that the train has crossed over and will be found in the block ahead. If, however, a train is in the block on the track to which the train is to cross, the signal-man must not permit the train to cross over until the train occupying the block has arrived at his tower.

11. When, from any cause, it is necessary to couple two or more trains together and to run them as one * * * * they shall not be separated under any circumstances until the train arrives at the block tower. If they are then separated, each train shall be governed thereafter as a single train.

12. Where home signals are not provided with distant signals, signal-men must in no case give the "block clear" signal, nor unlock the tower in rear, until the first train has passed the home signal by 400 yards or more.

13. A signal-man having orders for a train shall display a red signal in addition to the block signal.

14. In the absence of any signal, the train must stop, and the cause of failure to display the same must be ascertained.

15. Trains must, under no circumstances, pass signals at "danger," except as provided in block signal rules 3, 4, 5, 6, 7, 8, 9 and 10.

16. When an engine-man finds a signal at "danger" other than the block signal, such as a distant station signal, or a draw-bridge signal, he must come to a full stop, then pass the signal and run cautiously to the point of obstruction, obtaining thereby the protection of the signal. Rule 95, (flagging rule) however, must be observed by the conductor.

17. The use of the block signals and the rules governing same do not relieve employees in the train service from observing all other rules relative to the protection of their trains.

18. Conductors and engine-men are particularly requested to note the places at which the signal towers are being constructed along the line, so that, when completed and put in use, they can readily locate them.

Instructions for Working Lock and Block Instruments and Bell Code.

BELL SIGNALS.

BELLS MUST BE RUNG SLOWLY AND DISTINCTLY.

1. All right. Yes.
2. Train has cleared.
3. Unlock my lever. Passenger tracks, answer by plunge or ring 5 or 12.

3–1. Unlock my lever. Freight tracks, answer by plunge, or ring 5–1 or 12–1.

4. Train has entered block. Passenger track. Answer 1.

4–1. Train has entered block. Freight track. Answer 1.

5. Block is not yet clear. Passenger track. Answer 1.

5–1. Block is not yet clear. Freight track. Answer 1.

6. Is train coming to me? Passenger track? Answer 1 or 7.

6–1. Is train coming to me? Freight track? Answer 1 or 7.

7. No.
8. Testing by inspector.
9. Am going to clean lamps. Answer 1 or 7.

10. Send electrician. When using this signal always give number of tower in trouble.

11. Send mechanical repair-man. When using this signal always give number of tower in trouble.

Signal-men receiving 10 or 11 bells, with number of tower, will repeat signal to nearest telegraph station.

12. Have plunged. Passenger, answer 12. If answered by 1, give train a clearance card and allow it to proceed, announcing it by 4.

12–1. Have plunged. Freight, answer 12–1. If answered by 1, give train a clearance card and allow it to proceed, announcing it by 4–1.

5–4. Obstruction. Danger signal. Stop all trains. Answer by 5–4.

4–5–1. Train on track No. 1 broken in two.

4–5–2. Train on track No. 2 broken in two.

4–5–3. Train on track No. 3 broken in two.

4–5–4. Train on track No. 4 broken in two.

2–2. Stop and examine train. Passenger, answer 2–2.

2–2–1. Stop and examine train. Freight, answer 2–2–1.

2–3–2. Previous signal given in error.

4–3. Have train to let out of siding. To be answered by 5 or 5–1 or 4-3.

4–4. Is track clear to cross train over to opposite tracks between these towers? To be answered by 4–4.

5–5. Train has gone on siding and switch to main line is closed. If understood, repeat 5–5 to sender.

To Receive Train (Block Being Clear and Signals at Danger).—In answer to 3 taps of bell, pull the plunger on the instrument out firmly and carefully; this unlocks the lever in the next tower and locks up the plunger.

To Forward Train.—Ring 3 strokes on bell to man in advance of train. As soon as lever is unlocked by him ring 1 stroke and clear signal.

Place signal at "danger" as soon as train has passed it, and ring clear to man who sent train to you.

Signals must be answered immediately.

Do not tamper with the instruments.

The unnecessary use of the bell, or the use of signals not authorized, is strictly forbidden. In case of trouble call mechanical or electrical repair-man.

New York Central & Hudson River R. R. Co.

_____ DIVISION.

CAUTION CARD.

_____ *Tower,* _____ *189* _____ *M.*

To Engineer _____ *Engine.*

Train No. _____ *on* _____ *Track.*

PROCEED WITH CAUTION.

_____

OPERATOR.

NOTE.—The Engineer receiving this card, duly dated, timed and signed, will run to the next signal or point of obstruction with train under complete control, and as he knows the way to be clear, and on completion of trip will send the card to this office.

_____ Superintendent.

The "caution" card is of green paper, as a reminder to those using it that the movement is to be made under the "caution" or green signal.

New York Central & Hudson River R. R. Co.

.....DIVISION.

CLEARANCE CARD.

.....*Tower*.....*189*.....*M.*

To Engineer.....*Engine.*

Train No......*on*.....*Track.*

Signal cannot be Cleared; Proceed with Caution to the next Signal Tower.

.....

OPERATOR.

NOTE.—This card must not be used except in case of failure of block signals and when section has been duly reported clear by the operator at advance tower. The engineer receiving it, duly dated, timed and signed, will run to next signal with train under full control, and on completion of trip will send card to this office.

..... Superintendent.

CHAPTER XII

AUTOMATIC BLOCKING.

Automatic block signals are usually operated through the agency of electricity alone or of a combination of electricity and compressed air, by the passage of trains into and out of the block. Signal-men are not employed in the manipulation of these signals.

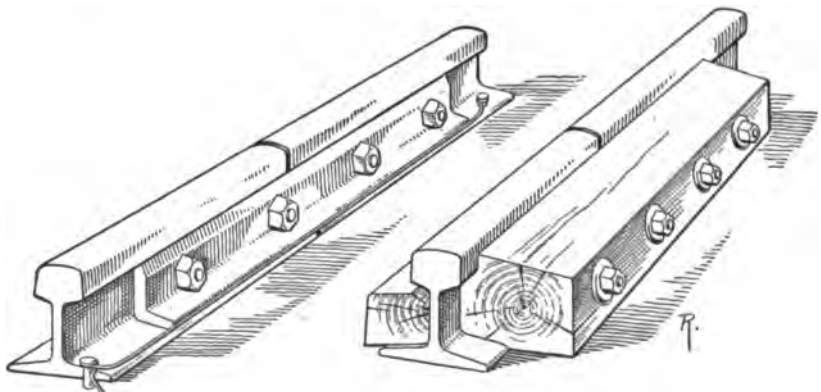
A track circuit is generally used in automatic blocking, for conveying the electric current to the signals, and this is the only method that will be referred to here. In arranging a track circuit, a gravity battery is commonly used, and is placed at the advance end of the block. A relay and the signal are placed at the

other end. Each line of rails is connected with a pole of the battery. The current passes along the rails of one side of the track, through the relay, thence along the rails of the other side of the track, thus forming a circuit. The relay controls a local circuit which works an electro-magnet, which in the simple electric system actuates the signal, and in the electro-pneumatic system permits compressed air to actuate it.

The electric power may be generated by a dynamo, and, indeed, this is the preferable method. The use of storage batteries in electro-pneumatic interlocking permits of a closer regularity of the quantity and pressure of the current, and results in considerable economy in operation.

As in other methods of blocking the line is divided into blocks or "circuits," the track of each block being insulated from the tracks of adjoining blocks. To insure good connections the rails in a block are joined at their end with wire to bridge the fish plates, the wire being rivited to the base of the rails. It is suggested that the wires be rivited to the web of the rails, as this would cause less injury to the rails. The insulation from each other of the rails of adjacent blocks is accomplished by inserting a piece of leather board, fiber or other insulating sub-

stance between the ends of the rails, and using wooden fish plates or splice bars to connect these rails.



WIRED JOINT. INSULATED JOINT.

There are two plans under which automatic block signals are operated: 1, the "normal-safety" plan, that in which the signals always show "clear" unless

the block is obstructed either by a train or otherwise; 2, the "normal danger" plan, that in which the signals are at "danger" at all times except when cleared by an approaching train, which can be done only when the block is clear of trains and other obstructions.

When the head end of a train enters an automatic electric block the current short circuits (that is, it takes the shortest path back to the battery) through the axles of the locomotive or car, and is thereby cut off from the relay, which then breaks the local circuit operating the signal. When the signal is passed by the rear end of the train, it goes to the "danger" position. In the "normal safety" plan, when the train passes out of the farther end of the block the signal again goes to "safety." In the "normal danger" plan the currents are so arranged that the signal sets at "danger" until it is again cleared by an approaching train.

Automatic block signals are applicable to junctions, railroad crossings and draw-bridges if manual interlocking is used. Separate signals are provided for the interlocking. The same rules apply to the block signals here as elsewhere. If the interlocking and block signals both show "clear" trains may proceed with speed. At a junction, where the route diverges, the block signal will show "clear" when

there is no train in the block ahead on the main line and the interlocking signal is lowered for a train to continue on the main line, or when there is no train in the block ahead on the branch line and the interlocking signal for the branch is lowered.

The Union Electro-Pneumatic System.

The general features of the electro-pneumatic system, as developed by the Union Switch & Signal Company, are: 1, a rail circuit with its batteries and relays; 2, an air compressor with its pipes to the signal posts, and 3, the signal posts themselves with their arms, air cylinders, and electrically-controlled valves.

Two semaphore signals are placed on a post about 50 feet to the rear of each section. The upper one, according to the general practice of to-day, is the "danger" or home signal, is painted red, and governs the section immediately ahead; the lower one is the "caution" signal, is painted green and works in harmony with the "danger" signal of the next section. Each semaphore is operated by a cylinder three inches in diameter, fitted with a piston, the rod of which is so connected as to move the signal to its "clear" position when air pressure from the main pipe line is applied to the piston, by means of the electric valves, that

being the position of the signals when the track is clear for the movement of trains. Each signal blade carries an appropriately colored lens, which covers a light when the blade is in the horizontal position, showing red if it is the upper signal, and green if it is the lower signal. A white light is exposed when the signal is in position to indicate that the track is clear. The system as above described is that of the duplex or overlapping blocks. If at any signal post (A) the top arm is lowered, and the bottom arm is horizontal, it indicates that the block to the next signal post (B) is clear, but that the second block (B to C) is occupied. If both arms are lowered, the track is clear from A to C. The air compressors may be of any type, but preferably not of that used with the ordinary air brake, which type has been found to be, when used for this purpose, uneconomical in steam consumption. They are usually placed in pairs, so that if anything should happen to one the other can be thrown into service immediately. A 2-inch pipe for conveying the air is carried directly from the compressor along the right of way of the railroad, and wherever a signal occurs a small branch pipe connection runs from the main air pipe to the signal cylinder. An auxiliary reservoir is placed at the bottom of each post for the purpose of collecting any moisture which may form in the column

of air. This is done to avoid having the signal cylinder frozen up. The air pressure should be maintained at about 60 lbs. to the square inch.

Following are the rules of the Pennsylvania Railroad, issued January 30, 1892, for the operation of the Union electro-pneumatic block system on the New York division of that road:

"These signals consist of two arms on each post; the upper is the home signal for the block; the lower is the distant signal for the home signal of the next block; they are located at the beginning of each block section.

"The normal position of these signals is at 'clear.' A train entering a block section will automatically set them; the home at 'danger,' and distant at 'caution.'

"A train finding a home signal at 'clear' and distant signal at 'caution' may proceed, expecting to find next home signal at 'danger.'

"A train finding a home signal at 'danger' must stop before passing it. After waiting one minute, it may then proceed with caution, expecting to find train on block. Should it find no train on block, report to Superintendent from first telegraph office, giving number of signal passed at 'danger.'"

The Hall Automatic Signal System.

In the Hall electric block system the signal instrument is contained in a case (popularly known as a "banjo") mounted on an iron or wooden post, the length of which may be varied to suit conditions.

Within the case is mounted a disk of red silk, with a red glass on the opposite end of the arm carrying the disk. By day a white glass, in the back of the home signal case, is exposed through the glass covered aperture in front, so long as the large red disk is held out of sight. The front of the case being dark, the indication of safety is thus shown by a white disk in the center of a dark ground. The falling of the large disk before the glass produces the danger signal, by showing red, and at the same time cuts off the strong contrast formed by the pure white light disk in the center of the dark case. The front opening is larger than the disk proper, so that when the signal is at "danger" there is a band of white shown around the disk.

At night the clear signal is obtained direct from a lamp, showing a white light through the small opening in the top of the case. On the signal assuming the dan-

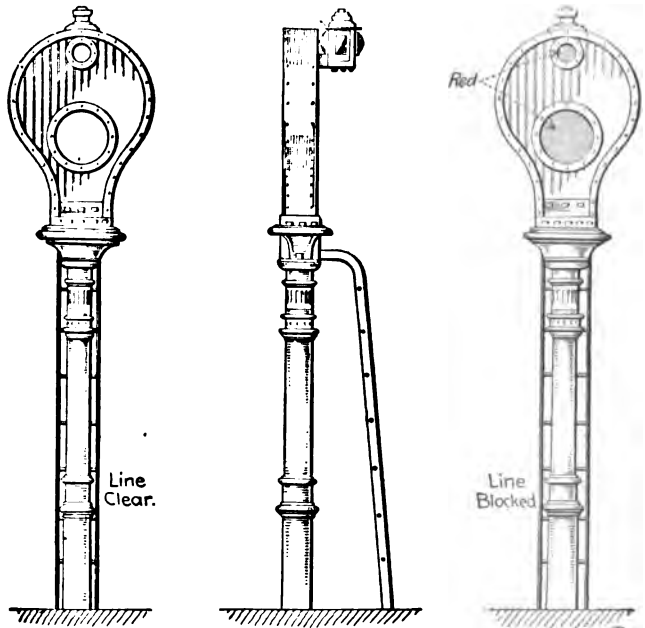


FIG. 2. THE HALL AUTOMATIC SIGNAL.

ger position a ruby glass lens is carried up before the small opening by gravity, giving a red light. When desired, the clear night indication may be green instead of white. In this case the single glass disk, above described, is replaced by a double disk, one green, the other red, these being placed at right angles to each other.

The distant signal is substantially of the same construction, but the disk is green, and the face of the case may be painted white, to distinguish this signal from the home signal. When at danger the green disk presents a strong contrast to the white surrounding case. At night a green lens is used to indicate "caution."

At junctions, cross-overs, sidings, etc., a switch instrument is used, which, through its electrical connections, causes the block signal to display "danger" when a switch is not set for the required movement.

A visible indicator is placed at main track switches to warn a trainman desiring to open a switch to let a train out on the main line. This indicator will show "danger" if an approaching train shall have passed a point 1,000 feet or more in advance of the home signal next back of the switch. If the main track is clear and the trainman therefore opens the switch, this operation sets at "danger"

the main track home signal of the block in which the switch is situated. The arrangement of the parts and of the circuits of the indicator are such that any failure will cause the indicator to assume the danger position.

The Lake Shore & Michigan Southern Railway Company operates the Hall electric block signals on its Michigan division under the following information and rules:

"The display of a red disk or red banner by day, or a red light by night, indicates 'danger—stop.'

"A white light displayed by night, or the absence of a red disk or red banner by day, indicates 'safety—proceed.'

"A small portion of the disk will be visible when the signal is at 'safety,' at the upper left hand edge of the opening in the signal case, and serves to show that the disk is there and connected with the signal instrument.

"Signals of the banner type are placed 225 feet within the blocks they respectively control, and should turn to 'danger' (if not already in that position), ahead of an approaching train when the first pair of wheels enters the block, the entrance of which is marked by the signal post.

"A signal will indicate 'danger' as follows:

"First.—When a train has passed it and has not passed out of the block which it controls.

"Second.—When any switch in that block is open.

"Third.—When a car or train stands on a siding, between the fouling point and main line, the position of such fouling point being indicated by a post marked 'F.'

"Fourth.—When the track is broken by removal or breaking of rail.

"Fifth.—Whenever either switch of any cross-over leading to the main track on which the signal is located, is open.

"A train finding a signal at 'danger,' shall come to a stop before reaching it, and shall wait there two (2) minutes (unless the signal shall clear in less time) before proceeding.

"If the signal goes to 'clear,' the train may proceed at the usual rate of speed; but, if the signal shall not have cleared, then the train at the expiration of two (2) minutes shall, after placing two torpedoes on rail (ten yards apart—one rail length), 50 feet from the rear of train, proceed cautiously and under full control, expecting to find the track obstructed or broken.

"Trains entering a block, as provided above, will be held responsible in case of an accident caused by overtaking a preceding train.

"No car or train shall stand on a siding within fouling distance of the main track.

"Any train leaving a part of the train in one block to do work in the next block, or making any unusual stop, must observe flagging rules, protecting the train as though there were no block signals in operation.

"A train which has taken a side track to allow another train to pass, shall not come out on the main line again until ten (10) minutes after the train has passed.

"A train desiring to come out on to the main line from a siding or cross-over, shall open the switch and wait three (3) minutes before proceeding, to allow a train which may have passed the preceding signal, time to run from the signal to such switch.

"When the block signal light is out, the conductor will notify the division superintendent from the first open telegraph office at which the train stops, giving number of signal and its location.

"The absence of a block signal light or an improperly displayed signal, will be considered and treated as a danger signal.

"When the number of a signal is covered, it indicates that the signal is out of service, and trains will proceed cautiously without coming to a stop.

"Conductors will report to the division superintendent, on blank forms provided for the purpose, from the first open telegraph office at which the train stops, all delays caused by signal, giving number of signal. At the end of a run, conductors will fill out blank report to correspond with any stops which they may have been obliged to make by reason of the signals, and send them to the division superintendent by mail."

Following are extracts from the rules for operating the Hall electric block signal system in the Chicago terminal district of the Illinois Central Railroad:

The signals are placed on bridges spanning the tracks, or on single posts. Where a bridge is used a train is governed by the signal standing over the right hand rail of the track occupied by the train. Signals on posts are placed immediately to the right of their respective tracks.

A train finding a signal at "danger" will stop and wait one minute or two minutes (depending on the instructions for that particular point which are given in the working time-table) before proceeding, unless the signal earlier returns to

"safety." A train passing a signal at "danger" after waiting the required time must proceed under control, expecting to find a train or open switch in the block.

Green block signals may be passed without stop when the view is clear. A train passing a green signal must proceed under control, expecting to find a preceding train in the block.

Whenever the view is obscured by fog or otherwise, trains must not proceed until the signal is known to be clear, or after waiting the required time, a flagman is sent in advance until a clear signal is reached.

When for any reason a signal is out of service the disk will be covered. Trains finding signals out of service will proceed with caution until a clear signal is reached.

Through passenger trains (on tracks and at points indicated on time-table) finding a block signal at danger, may pull up to the station, do their station work, and proceed in the usual manner after a stop of two minutes has been made.

Suburban trains finding signals at "danger," when such signals are located not more than 500 feet beyond the point at which the station stop is made, will, unless

the signals earlier return to "safety," remain at the stations the required time before proceeding. Two stops at such stations are unnecessary.

Cars and engines standing on a siding must clear the fouling point with main track two full rail lengths, as to stand nearer sets the main track signals to "danger."

Each switch is protected by a bell which will ring when a train is approaching it in the block, and the switch must not be opened until the train has passed.

CHAPTER XIII.

MACHINE BLOCKING FOR SINGLE TRACK LINES.

Machine blocking, which has not as yet been introduced extensively in this country, appears to offer the safest method of single track blocking yet devised.

The principle involved in machine blocking is a modification of the staff system. Staff or tablet machines are used, one being placed at each end of each block, and these machines are so constructed that the withdrawal of a staff or tablet from one machine automatically locks the apparatus so that a second staff or tablet cannot be obtained at either end of the block until the first one is restored to one or other of the two machines of the block.

In England, single track lines were at first operated by means of the "pilot guard," a method still employed there on a few short branch lines.

Under this arrangement, a pilot accompanies every train, when possible, but when it is necessary to start two or more trains from one end of a section that is under the pilot's control, before a train is to be started from the other end, the pilot must furnish the conductor in charge of each train not accompanied by himself, with a printed "pilot ticket" (see page 235) properly filled out and signed, and he must personally give the order for starting the train and must himself accompany the last train.

The next step was to introduce the working by train staff, and this was afterward extended to the train staff and ticket system, to meet the case of more than one train passing in one direction before a train was required to be run in the opposite direction.

By this system a train staff or a train staff ticket is carried with each train, and without a staff or ticket no train is allowed to run in the section. The staff itself is a piece of wood or of hollow metal. The ticket, of convenient size, is a printed form authorizing the engine-man, after seeing the train staff for the section, to proceed between the stations named on the ticket. Each staff has engraved or marked on it the name of the staff station at each end of the one section to

which it applies. The staffs, boxes and tickets for the different sections are painted or printed in different colors, and the staffs of adjoining sections are different in shape. The train tickets are kept in a ticket box at the staff station, and the key to unlock the ticket box is the staff itself.

The moving of trains by the staff system is about as follows: Supposing that a staff section extends from A to B, and that there are several trains at A to move to B. Each of these trains except the last takes a ticket. The last train takes the staff. The conductor and the engine-man of each preceding train must see the staff, however, before leaving A; this is a precautionary measure to prevent accident through trains entering the block when the staff is perhaps held by a train coming in the opposite direction. The party finally taking the staff locks the staff ticket box before leaving.

This form of working, with the additional protection afforded by the block signalling, remained in force for a considerable time on single track lines. In more recent years it has to a large extent been superseded by the electric train staff (or tablet) system, the advantages of which are (1) that a train can be sent forward from either end of the section without awaiting the arrival of the staff from the other end,

a frequent source of delay under the old method, and (2) that greater security in working is obtained on account of the impossibility of withdrawing a staff from the machine at either end of the section without the concurrence of the signal-man at the other end. The machines in general use are the Webb & Thompson electric train staff machine and the Tyer train tablet machine. A machine is placed at each end of the block, the two machines being connected by an electric circuit. In each block station therefore there will be two independent machines, not connected in any way; one of these is for the block in the rear and the other for the block in advance. Thus block station B would have one machine connected with a machine at A, and another machine connected with a machine at C. The operation of either style of machine is simple, and practically the same as that of the other.

The Webb & Thompson train staff machine consists of an iron pillar with a vertical slot through nearly its entire length, in which is a supply of staffs. For sending more than a single train in one direction before the arrival in each case of the preceding train at the staff station in advance, a machine with a separate slot for holding a special staff is used. The head of the machine, called the locking

case, contains the electrical apparatus for manipulating the machine, and, in the case of a special staff machine, the staff ticket box. Only one staff can be withdrawn at a time from the two machines governing a block, and this only with the

WEBB & THOMPSON TRAIN STAFF MACHINE.

consent of the signal-man at the receiving station who alone controls the staffs at the sending station. Another staff cannot be removed from either machine until the one already out is restored at one or the other end of the block. Thus, when

a staff has been taken out at station A another cannot be taken out at station B, nor can a second staff be taken out at A until the staff previously withdrawn has been restored to the machine at either A or B. A staff can be replaced, however, in a machine without previous communication with the opposite end of the block. Communication between block stations is effected by means of the usual electric bells, a bell being attached to each machine.

Following is the method of working the staff machine:

Let A and B represent two block stations. Before starting a train from A towards B the situation with reference to the block is ascertained by means of the bell code. If the block is clear of trains and obstructions, B, when asked, unlocks A's machine. This allows A to withdraw one staff, which is given to the engine-man, who, on the arrival of the train at B hands it over to the signal-man there to place in his machine. As neither of the machines governing the block can be unlocked while the engine-man has the staff, it is of course impossible to furnish a staff for another train until he has delivered his staff.

It is not necessary to place staff machines at block stations not at passing sidings, as all that the staff is intended to do is to govern the non-meeting move-

ments. When there are intermediate block stations, staff machines with special staffs and tickets (in addition to the regular staffs) may be used. As the principal function of the intermediate block stations is to govern the non-following movements, these stations would be equipped with signal bells and out-door signals only.

For example, suppose a train is moving from A to D, at each of which points is a passing siding; also that there are intermediate block stations B and C. Train staff machines are located at A and D. The train receives a staff at A, and carries it to D, where it is exchanged for another staff. The block stations at B and C are merely spacers for the purpose of keeping following trains apart. If there is more than one train to proceed towards D the special staff and train tickets are used. Each train except the last takes a ticket instead of a staff and goes forward when the A–B block is clear. The last train takes the staff and any remaining tickets. On the arrival of the last train at D all the tickets are locked up in the machine, and the special staff is placed in its slot, which action restores the machines at A and D to their normal, or locked, condition.

Tyer's train tablet machine is operated similarly to the Webb & Thompson

machine. A metal tablet is used instead of a staff, the tablet being simply a train staff in another form.

Besides being absolute blocking instruments these machines are adapted to the protection of drawbridges and junctions, and would seem to make such places as safe as human foresight can make them.

For ordinary block working it would be a serious hindrance to traffic if all trains were required to slow down or stop to allow the engine-man to receive and deliver each staff. Devices have therefore been made for taking the staff while the train is running at good speed. The method of exchanging train staffs or tablets with a train in motion is similar to that of catching mail bags by moving trains, an appliance similar to the mail catching device being used. The apparatus is double, having a delivering as well as a receiving end, so that a staff or tablet can be delivered mechanically at the block station at the same time that another is taken on.

To prevent injury to the staffs or tablets in making the exchange, they should be put in a stout leather case. In arranging the exchanging appliances on locomotives and at block stations, care should be taken to get the appliances all in line, that is, the same distance from the center of the track, so as to ensure their proper action.

REGULATIONS OF THE LONDON AND NORTH WESTERN RAILWAY FOR WORKING SINGLE LINES OF RAILWAY ON THE ELECTRIC TRAIN TABLET OR ELECTRIC TRAIN STAFF SYSTEM.

384. The object of the system of train tablet or electric train staff signalling is to prevent more than one train being between any two tablet or staff stations at the same time, and, when no train is in the section between two tablet or staff stations, to admit of a train being started from either end. This is accomplished by every train carrying a train tablet or train staff, one tablet or staff only being obtainable from the tablet or staff instruments of the same section at the same time.

385. A train tablet or train staff must be carried with each train, and no train must leave any tablet or staff station, except as provided in rules 391, 392, 403, 406 and 407, unless the engine driver (as explained in rules 384 and 391) is in possession of the tablet or staff for that portion of the line over which he is about to travel.

Each train tablet and train staff has engraved or marked on it the name of the

tablet or staff station at each end of the section to which it applies, and the tablets and staffs of adjoining sections are different in shape or color.

386. The system under which the electric train tablet and electric train staff instruments are to be worked, and the mode of indicating the description of approaching trains, will be laid down in the code of regulations supplied to signal-men or exhibited in the signal boxes and at tablet and staff stations for the guidance of the signal-men or other persons in charge.

387. The "danger" signal must always be kept exhibited at all the fixed signals at tablet and staff stations, except when it is necessary to lower or turn them off for a train to pass; and before any signal is lowered or turned off, care must be taken to ascertain that the line on which the train is about to run is clear and properly protected.

At places which are not tablet or staff stations, the "all right" signal must, unless special instructions to the contrary are issued, be kept exhibited at all the fixed signals (where such signals are provided), except when required to be placed at "danger" for the protection of trains having to stop in the section, or any other obstruction that may exist on the main line which the signals are intended to protect.

When trains which have to cross each other are approaching a tablet or staff station in opposite directions, the signals in both directions must be kept at "danger," and when the first train has been brought to a stand, the home signal applicable to such train may be lowered to allow it to draw forward to the station or to the starting signal, and after it has again come to a stand, and the signalman has seen that the line on which the other train will arrive is quite clear, the necessary signals for that train may also be lowered.

Where starting signals are provided, except in the cases referred to in rules 402, 403, 405, 406 and 407, the starting signal must not be lowered until a train, tablet or train staff has has been obtained for the train to proceed to the tablet or staff station in advance.

388. No train must foul the signal line after permission has been given for a train to enter the other end of the section; nor must a train foul the single line outside the home or advanced starting signal for shunting purposes, unless the engine-driver is in possession of the tablet or staff for the section so fouled, except as follows:

Exception.—On those lines where shunting staffs are provided, so interlocked

with the tablet or staff instrument that the shunting staff cannot be obtained when permission has been given for a train to approach from the opposite end of the section, and permission cannot be given for a train to approach from the opposite end of the section, except when the shunting staff is in connection with the tablet or staff instrument—unless instructions to the contrary are issued, an engine-driver, when in possession of the shunting staff, and when authorized by the signal-man to do so, may proceed with his engine on to the single line at the end of the section to which the shunting staff applies, as far as is necessary for shunting purposes at the tablet or staff station, without being in possession of a train tablet or train staff.

389. The signal-man or other person in charge of the tablet or staff working for the time being is the sole person authorized to take a tablet or staff from, or place a tablet or staff in, the instrument, or (except where some other person is specially appointed to the duty) to receive a tablet or staff from, and deliver it to, the engine-driver, who, whilst it is in his charge, must carry it in the socket or other place provided for the purpose.

390. When a train arrives at a tablet or staff station and the signal-man has received the train tablet or train staff, he must ascertain that the whole of the train is clear of the section, and then deposit the tablet or staff in the instrument, except as explained in the following clause:

If the train should pass with tail lamp missing or out, the signal-man must send the "train passed without tail lamp" signal (as laid down in the block telegraph regulations) to the tablet or staff station on each side of him, but must not deposit the tablet or staff in the instrument. The signal-man at the tablet or staff station in advance must stop the approaching train and ascertain from the guard whether his train is complete. If the train is complete the signal-man must give the "train out of section" signal, and the signal-man at the tablet or staff station from which the "train passed without tail lamp" signal was sent must then deposit the tablet or staff in the instrument and give "train out of section" signal to the station in rear. Should the signal-man become aware as the train passes into the section in advance, or on receipt of information from the signal box in advance, that a portion of the train has been left behind, steps must be taken to

clear the obstruction before any other train is allowed to enter the section, the first available engine at either end of the tablet or staff section being detached from its train for the purpose of clearing the line.

If the engine which is to remove the obstruction starts from that end of the section where the train tablet or train staff is out of the instrument, the signal-man must hand such tablet or staff to the engine-driver and instruct him to proceed cautiously to the vehicle or vehicles which have become detached, and remove them to the most convenient end of the section.

If, however, the relieving engine is to start from the other end of the section, then the train tablet or train staff must (after all arrangements are made) be placed in the instrument, so that one may be withdrawn at the other end of the section to enable the relieving engine to proceed to the vehicle or vehicles which have become detached, and remove them to the most convenient end of the section.

In either case, the signal-man at each end of the section must communicate with each other and arrive at a clear understanding how the obstruction is to be removed.

Under no circumstances, except as provided in the previous clause and in rules

402 and 403, must a train tablet or train staff be transferred from one train to another without being passed through the instrument and dealt with in accordance with the regulations.

391. When a train has more than one engine in front, or when two or more light engines are coupled together, the train tablet or train staff must be shown to each engine-driver, and delivered to, and carried by the driver of the last engine.

When the train has also an engine in the rear, the train tablet or train staff must be shown to the engine driver or engine-drivers in front of the train, and delivered to, and carried by the engine-driver in the rear of the train. Trains must only be assisted by an engine in the rear on those sections of the line where special instructions are issued giving permission for this to be done.

An assisting or banking-engine must not in any case leave the train it is assisting or banking, except at a tablet or staff station, unless authorized by the superintendent of the line under special regulations.

392. No engine-driver with a train must, except as provided in rules 403, 406 and 407, leave a tablet or staff station until he has received the proper train tablet or train staff for that section of the line over which he is about to travel, or it has

been shown to him as required by rule 391. After receiving the tablet or staff, the engine-driver must not proceed until all the necessary fixed or other signals have been exhibited. He must keep the train tablet or train staff under his own charge (except as explained in rules 397, 402 and 403) until he reaches the end of the section, when he must give it up to the signal-man or other duly authorized person.

Engine-drivers must be extremely careful not to take the tablet or staff beyond the station at which it ought to be left.

393. Except as provided in rules 403, 406 and 407, an engine-driver will render himself liable to dismissal if he leaves a tablet or staff station without the train tablet or train staff for that section of the line over which he is about to run; or unless it has been shown to him as required by rule 391.

394. At tablet or staff stations which are approached by trains in opposite directions at the same time, the line must be considered clear, and the "train out of section" signal must, unless special instructions be issued to the contrary, be given immediately the last vehicle (with tail lamp attached) has been drawn clear on to the loop line, except in cases where no train is approaching or requires to proceed in the opposite direction, when the "train out of section" signal must not

be given to the tablet or staff station in the rear until the train has passed the starting signal and is proceeding on its journey, or has been shunted clear. At tablet or staff stations which are not approached by trains in opposite directions at the same time, the line must be considered clear, and the "train out of section" signal must be given immediately the last vehicle (with tail lamp attached) has passed the starting signal and the train is proceeding on its journey or has been shunted clear. When practicable, signal-men must themselves see the tail lamp on the last vehicle before giving the "train out of section" signal to the tablet or staff station in the rear; but in cases where a train does not pass the signal-box before shunting clear, or when a train has been brought to a stand, clear on the loop line, before reaching the signal-box, and it is necessary to give the "train out of section" signal to the tablet or staff station in the rear, the signal-man must be informed by the guard or some other responsible person, that the whole of the train has arrived with the tail lamp attached, before giving the "train out of section" signal to the tablet or staff station in the rear.

395. The engine driver of a ballast train that has to do work on the line must be told, when receiving the train tablet or train staff, to which end of the section

it is to be taken, and at what time it is to be there, in order to clear the line for the next train.

When a ballast train in possession of the train tablet or train staff is at work on the line, it will not be necessary to send out flagmen to protect it, as directed in rule 321.

396. When it is necessary for a plate-layers' lorry * to go through any of the tunnels specially enumerated in the appendix to the working time table as coming within the application of this rule, the ganger or leading man in charge of the lorry must be in possession of a train tablet or train staff, and the lorry must be signalled on the train tablet or train staff instruments, in accordance with the authorized code. Should the lorry after passing through the tunnel be removed from the rails before reaching the next tablet or staff station, the ganger or leading man must take the tablet or staff to the signal-man at the end of the section nearest to him, except when the tablet cannot be restored to the instrument from which it was obtained, in which case it must be taken to the tablet station at the

* Trackmen's hand car.

opposite end of the section, and he must inform the signal-man that the lorry is clear of the line and hand the tablet or staff to him.

Lorries passing through all other tunnels must be protected solely by the plate layers'* own signals.

397. Points giving communication between the sidings and the main line controlled by the train tablet or train staff cannot be opened without the tablet or staff for that section of the line where the siding is situated, and the tablet or staff cannot be removed until the points have been placed in the proper position for trains to pass upon the main line, and securely locked so as to prevent vehicles passing from the sidings on to the main line.

On arriving at a siding, the points of which are controlled by train tablet or train staff, the engine-driver must hand the train tablet or staff to the guard or man in charge of the siding, to enable the points to be unlocked. When the necessary shunting has been completed, and the points have been placed in the proper position for trains to pass upon the main line, the guard or man in charge

* Trackmen.

of the siding must return the tablet or staff to the engine driver, and the latter must not proceed on his journey until he has obtained possession of it.

398. The working time tables or appendices, issued for the guidance of the servants, will contain a list of the tablet and staff stations and of the siding points controlled by the train tablets and train staffs.

399. When a special train has to be run without previous printed or written notice, the usual special train tail signal must, if possible, be attached to the preceding train for the guidance of the plate-layers and others employed of the line, but as special trains or engines have frequently to be run without previous notice of any kind, it is necessary for the staff along the line to be, at all times, prepared for such extra trains.

A special tail board or tail lamp need not be carried by preceding trains of which previous printed or written notice has been given.

400. On train tablet or train staff sections where a greater number of trains are run in one direction than in the other, causing the train tablets or train staffs to accumulate at one end of the section, the tablets or staffs must, when necessary, be transferred (by the man appointed by the telegraph superintendent for the pur-

pose,) from the tablet or staff instrument at which the tablets or staffs accumulate to the instrument at the other end of the section. The number of tablets or staffs removed by the man appointed by the telegraph superintendent must be recorded by him in the train tablet or train staff register provided for the purpose, and the signal-man must sign the entry and insert the time at which the transaction takes place.

The signal-man at the tablet or staff station to which the tablets or staffs are transferred must, immediately on receipt, compare the number recorded in the lineman's register with the number of tablets or staffs received, and when he has satisfied himself that the number is correct, and that the tablets or staffs have been deposited in the proper instrument, he must sign the register, and insert the time at which the transaction takes place.

NOTE.—The number of electric train staffs removed by the lineman must always be an even number, that is 2, 4, 6, and so on.

401. If a train tablet or train staff should be damaged so that it cannot be deposited in the instrument, the lineman must be at once sent for, and on his arrival he must, in the presence of the station-master or other person in charge,

adjust the instrument so as to admit of the tablet or staff working being carried on without the damaged tablet or staff, which must be taken away by the lineman for repair (see note below in respect to the train staff). Until the lineman arrives and the instrument has been adjusted no train must be allowed to travel over the section affected, except in accordance with the instructions for working by pilotman (see rule 407).

NOTE.—Should it be necessary to remove a second staff to put the instrument in phase, the lineman must take such second staff and lock it up until the damaged staff is repaired, when they must both be restored to the instrument where they are most needed.

Should a train tablet or a train staff be damaged after it has been withdrawn and before it has gone forward into the section in advance, the train for which it has been withdrawn must not be detained for pilot-working, but must be sent away with the damaged staff, and the lineman at once sent for.

Should a train tablet or train staff be lost, the single line working must be conducted by pilotman in accordance with rule 407 until every possible enquiry and search have been made for the missing tablet or staff, and, when it has been

established beyond doubt that it cannot be found, the lineman must be sent for and the instrument adjusted by him so that the ordinary working may be resumed. In the event of the tablet or staff being afterwards found, it must be kept by the station-master or other person in charge until the lineman can arrange to return it to the instrument.

402. In the event of an engine becoming disabled between two tablet or staff stations, the fireman must take the train tablet or train staff to the tablet or staff station from which assistance is most likely to be obtained, and, after informing the signal-man and showing him the tablet or staff, must personally hand it over to the driver of the engine appointed to proceed to the assistance of the disabled engine, and accompany him to the place where he left his own engine, and the driver of the disabled engine must not allow his engine to be removed until the assisting engine has arrived. The driver of the assisting engine, after removing the disabled engine and the whole of the train (if the disabled engine was working a train) to the most convenient end of the section, must then hand over the tablet or staff to the signal-man or other authorized person, who must, when the description of instrument in use makes this necessary, send it to the other end of the

section, either by train or special engine, as may be required for the proper and expeditious working of the traffic.

The fireman of the disabled engine must not on any account allow the train tablet or train staff to pass out of his possession until he hands it over to the driver of the assisting engine, and the driver of the assisting engine must not allow it to pass out of his possession until the disabled engine with the whole of the train (if any) is removed clear of the section, except when the line is obstructed and special arrangements are made for working in accordance with rule 403.

The first train passing through the section after the line is again clear must be stopped, and the engine-driver instructed to proceed cautiously through the section.

403. Should an accident occur of such a nature as to obstruct the line, and the traffic is likely to be stopped for any considerable time, special arrangements must be made for working the trains to and from the tablet or staff station on each side of the point of obstruction. The train tablet or train staff must be retained to work trains between the point of obstruction and the tablet or staff station from which the tablet or staff was issued, and, on the other side the traffic must be conducted by a pilotman, in accordance with the following instructions:

The guard must put the engine-driver in charge of the point of obstruction, and go himself to the end of the section to which the train was proceeding and arrange for three or more, as may be necessary, of the printed forms provided for the purpose of establishing working by pilot-man during obstruction (see page 233 for specimen form) to be filled up; one of these must be delivered to the signal-man in charge of the tablet or staff station where pilot working commences, the second must be retained by the pilot-man, and the third must be conveyed to the engine-driver in charge of the point of obstruction. The pilot-man must wear a distinctive badge which, until the regular badge can be obtained, must be a red flag tied round the left arm. So soon as he is satisfied that the arrangements are understood, trains may be allowed to go on to the single line under the control and by the permission of the pilotman. The guard must accompany the first train to the point of obstruction. The engine-driver, when put in charge, must hand the train tablet or train staff to the fireman, and instruct him to take it back to the tablet or staff station from which it was issued, to work trains between that station and the point of obstruction until the line is clear, when it must be dealt with in accordance with the instructions contained in rule 404. * * * *

The line on each side of the obstruction must be protected in accordance with the rules, and the guard and fireman will be held responsible for taking care that this is done until men are appointed specially to perform the duty.

404. When the line is again clear no train must be allowed to pass the point where the obstruction existed without the train tablet or train staff. The pilot-man must accompany the first train carrying the train tablet or train staff to the tablet or staff station to which the train was proceeding at the time of the accident, and after the engine-driver has given up the tablet or staff to the signalman and the pilotman has withdrawn his arrangements for pilot-working, the traffic will again be conducted in accordance with the train tablet or train staff regulations.

In no case of obstruction away from a tablet or staff station must a train tablet or train staff be restored to the instrument at either end of the section until the section is clear, except as laid down in rule 390.

405. When a train or portion of a train is left upon the single line from accident, or inability of the engine to take the whole forward, and it becomes necessary for the engine to return to the train or rear portion of the train from the tablet or

staff station in advance, the engine-driver must retain possession of the train tablet or train staff until the whole of the train is removed from the section. After sunset and during foggy weather or falling snow, the guard must place a red light on the front of the leading vehicle.

406. Should a failure occur to an engine assisting a train in the rear, the driver of the train engine must send his fireman to the driver of the assisting engine, and obtain from him an order in writing authorizing the driver of the train engine to return from the tablet or staff station in advance for the remainder of the train. The train engine must then proceed to the tablet or staff station in advance, and after disposing of the front portion of the train, the engine-driver, after informing the signal-man what he is about to do and showing him the written order, must return and remove the rear portion of the train and the disabled engine from the section.

Should the assisting engine fail and the train proceed, owing to the driver of the train engine not being aware of the failure of the assisting engine, the fireman of the assisting engine must act as directed in rule 402, and the disabled engine must not be moved until the relieving engine has arrived.

407. In the event of the failure of the train tablet or train staff communication between any two tablet or staff stations the working of the traffic over the section must at once be arranged for by means of a pilot-man. If the speaking telegraph or telephone communication is available, the station-masters or other responsible officials at both ends of the section must communicate with each other by telegraph or telephone (the communication being written on the proper forms in the usual way), and agree as to who shall arrange for pilot-working, and as soon as a definite understanding has been arrived at, the station-master or other responsible official who undertakes to make the arrangements for working by pilot-man must fill up three of the printed forms (see page 232 for specimen form) for establishing working by pilot-man during the failure of the apparatus; one of these he must deliver to the signal-man at the tablet or staff station at his end of the section, and the other two must be given to the pilot-man. The pilot-man, when satisfied that the signal-man has received the printed form duly filled up, and that he understands that no train is to be allowed to enter the section until he returns, must proceed as quickly as possible to the other end of the section, using the best means at his disposal for the purpose, but must not, unless there is a train tablet or

train staff out of the instrument and in his possession, or unless one can be withdrawn from the instrument at his end of the section, use an engine or any railway vehicle other than a plate-layer's trolly, and he must deliver one of the forms to the signal-man there, retaining the other for himself. The signal-man at each end of the section must know the man appointed as pilot-man, and must countersign the form for pilot-working held by him, the form held by each signal-man being in like manner countersigned by the pilot-man. Afterwards trains may be allowed to enter the section in accordance with the following instructions:

The pilot-man must inform the engine-driver and guard in charge of each train of the circumstances, and, when practicable, accompany every train, but when it is necessary to start two or more trains from one end of the section under his control before a train has to be started from the other end, he must furnish the engine-driver in charge of each train not accompanied by himself with one of the printed pilot-man's tickets, where such tickets are in use (see page 235 for specimen ticket), properly filled up and signed, must personally start such trains, and himself accompany the last train. The tickets granted in these cases will apply only to the single journey to the other end of the section, where they must be immediately

given up to the signal-man, who must at once cancel them by writing the word "cancelled" across the face of the ticket, and after ordinary working has been resumed, they must be forwarded to the superintendent with a report giving full particulars. After issuing a ticket or starting a train which he does not accompany, the pilot-man must not permit another train to enter the section until he has received intimation by a telegraph or telephone message from the other end of the section that the train holding the ticket has arrived. In the event of the speaking telegraph or telephone, as well as the tablet or staff instrument failing, the pilot-man, after starting a train, may permit another following train to enter the section after an interval of not less than 10 minutes, instructing the engine-driver to proceed cautiously; but when a train requires to stop at any intermediate place at which there are no fixed signals, the pilot-man must accompany such train.

The pilot-man, in the event of there being a tablet or staff out of the instrument at his end of the section, or if one can be withdrawn from the instrument at his end, when the tablet or staff communication fails, must take possession of such tablet or staff, and if there is an engine available, he may use the engine for the purpose of conveying the forms to the tablet or staff station at the other end of the

section. He must keep the tablet or staff in his possession until the tablet or staff apparatus is again repaired and ready for use; and on arriving at the other end of the section, he must, when delivering the form to the signal-man there, show him the tablet or staff, and also show it to the engine-driver of every train passing over the section during the time that pilot-working is in operation.

Should the speaking telegraph or telephone, as well as the tablet or staff communication have failed, and the men at each end of the section be unable to communicate with each other, the station masters or other responsible officials at both ends of the section must arrange for pilot working, and the pilot-men appointed at both ends must proceed along the railway in order that they may meet, and on doing so they must go together to the nearest or most convenient end of the section. The pilot-man who returns to the station from which he started must obtain the form which had been handed to the signal-man there, and return it and the other two forms in his possession to the station-master or other official who filled them up, and the latter must at once cancel them by writing the word "cancelled" across them. The other pilot-man must hand one of his forms to the signal-man as directed above, and act as pilot-man.

The pilot-man must wear a distinctive badge, which, until the regular badge can be obtained, must be a red flag tied around his left arm.

408. Should the pilot-man give up the working to another, the name of the second pilot-man must be substituted on new forms, to be held by the signal-man at both ends of the section; but this can only be done by the person who arranged the pilot-working, and he, on doing so, must collect and cancel the forms previously issued.

After one pilot-man has been relieved by another, the pilot-man who has been relieved must not ride upon any engine until he resumes duty as pilot-man.

409. Should the signal-men be changed during the time the pilot-working is in operation, the man coming on duty must be made acquainted by the man going off duty, with the arrangement in force, and with the person acting as pilot-man. He must, before taking charge of the signal-box, countersign the form held by the pilot-man.

410. Steps must be immediately taken to have the tablet or staff apparatus put into working order again.

When the tablet or staff apparatus is again replaced and ready for use, the

pilot-man must withdraw the notice for pilot-working at one end of the section, then take the tablet or staff from that end of the section to the other end of the section, and after delivering it to the signal-man there, and withdrawing the notice for pilot-working, the traffic will be again conducted in accordance with the train tablet or train staff regulations, and all forms which have been issued for pilot-working must be collected and sent to the superintendent.

411. Signal-men must not, on any account, take off their signals to allow any train to pass into any section that is being worked by pilot-man, except under the pilot-man's instructions, and when he is present.

.....RAILWAY.

Electric Train Tablet or Train Staff System.

WORKING OF SINGLE LINES BY PILOT-MAN DURING FAILURE OF APPARATUS.

.....Station. 189

Electric Train Tablet or Electric Train Staff apparatus between .....and .....
having failed, all traffic between those two places will be worked by pilot-man in accordance with rules 407 to 411.

.....will act as pilot-man, and no engine or train is to be allowed to pass on to the section unless he is present and personally orders the engine or train to start.

This order is to remain in force until withdrawn by the pilot-man. Signed.....

To .....

* Noted by.....

Station or Box.....time.....

* Noted by.....

Station or Box.....time.....

* Noted by.....Pilot-man.

* These signatures must be made on the copy held by the pilot-man.

The above forms must be filled up and used whenever it is temporarily necessary, owing to the electric train tablet or electric train staff apparatus having failed, to work the traffic by pilot-man.

Six of these forms must be kept in a convenient place at each tablet and staff station, so as to be available at any moment, night or day.

Before pilot working is commenced a copy of this form must be signed by the person in charge at each tablet or staff

station where the tablet or staff apparatus has failed, and be kept by the pilot-man, who must see that each of the men signing the form retains a copy for himself.

In the event of a station-master himself acting as pilot-man, he must address and give the form to the person he leaves in charge of his station.

Station-masters and other persons in charge receiving this form will be held responsible that the inspectors, foremen, signal-men, and others at their station, are immediately made acquainted with the circumstances, and are instructed in their necessary duties.

NOTE.—The time at which this form is cancelled must be written across it.

_____ RAILWAY.

Electric Train Tablet or Train Staff System.

WORKING OF SINGLE LINES BY PILOT-MAN DURING OBSTRUCTION.

.....Station. 189

The single line between.....and.....being obstructed, the traffic between.....and the place of obstruction will be worked by pilot-man in accordance with rules 403 and 404.

.....will act as pilot-man, and no engine or train is to be allowed to pass on to the section where the obstruction exists, unless he is present and personally orders the engine or train to start.

This order is to remain in force until withdrawn by the pilot-man. Signed.....

To.....

* Noted by.....

At place of obstruction. Time.....

* Noted by.....

Station or box ..... Time.....

* Noted by.....Pilot-man.

* These signatures must be made on the copy held by the pilot-man.

The above form must be filled up and used whenever it is temporarily necessary, owing to obstruction on a single line, to work the traffic by pilot-man.

Six of these forms must be kept in a convenient place at each train tablet, or train staff station, so as to be available at any moment, night or day.

Before pilot-working is commenced, a copy of this form must be signed by the person in charge at each end of the section on which it is intended to establish pilot working, and be kept by the pilot-man, who must see that each of the men signing the form retains a copy for himself.

In the event of a station-master himself acting as pilot-man, he must address and give the form to the person he leaves in charge of his station.

Station-masters and other persons in charge receiving this form will be held responsible that the inspectors, foremen, signal-men, and others at their station, are immediately made acquainted with the circumstances, and are instructed in their necessary duties.

On the other side of the obstruction the line will be worked by the train staff or train tablet as directed in rule 403.

NOTE.—The time at which this form is cancelled must be written across it.

Form of Pilot-man's Ticket.

(Front of Ticket.)

_____ RAILWAY.

PILOT-MAN'S TICKET.

TO BE USED IN ACCORDANCE WITH RULE 407.

Train No......

To the Guard and Engine Driver:

You are authorized to proceed from

_____ *to* _____

Pilot-man following

*Signature of Pilot-man*_____

Date.....

(Back of Ticket.)

This ticket is to be given up by the Engine-driver immediately on arrival, to the person in charge of the Tablet or Staff Station to which he is authorized to proceed, to be dealt with as the latter may be instructed by the Superintendent of the Line.

In addition to the bell code, given on page 86, the London & North Western Railway uses bell signals as follows in working on the electric train staff system :

5–2. Release staff for shunting.

2–5. Shunting completed.—Staff replaced.

When it is necessary to withdraw a staff for shunting purposes on the single line the signal-man must give the prescribed bell signal, and when the shunting is completed and the single line is again clear, the staff must be restored to the instrument, and the prescribed signal "shunting completed—staff replaced" must be given to the staff station in advance.

4–4–4–4. Signal for adjusting staffs.

In the event of the supply of train staffs at one end of the section becoming so reduced as to leave four only, and the number is likely to go on decreasing, owing to more trains having been dispatched in one direction than the other, the telegraph lineman must be at once advised, in order that the necessary adjustment may be made, and he alone will be held responsible for performing the duty; but it must not be done at places where there is a station-master, except in his presence. Before taking out the staffs, the telegraph lineman must advise the signal-man at the other end of the section of what he is about to do, by ringing 16 strokes on the bell (thus 4–4–4–4), which signal must be acknowledged. He must then unlock the instrument in the presence of the station-master and signal-man, and take out the number of staffs that he requires; this must on every occasion be an even number (2–4–6–8–10, etc.) and under no circumstances must an odd number of staffs be transferred. The staffs withdrawn must be carefully strapped together. After taking out the requisite number, the lineman must replace the instrument in proper working order, and under no circumstances must he give one of the staffs in his possession to the driver of the train by which he travels. He must not permit any staff to be taken from the instrument, or any one to interfere with it while he is mak-

ing the necessary adjustment, neither must he interfere with the instrument while a train is traveling in the section in either direction. On arrival of the train at the other end of the section, the signal-man there must first obtain the staff from the driver and place it in the instrument, and after noting the number of staffs which the lineman has brought with him, the lineman must place these staffs also in the instrument through the slot in the usual way. The telegraph lineman must record in the train register at each end of the section the number of staffs transferred and the date; and the signal-man at each end of the section must also confirm the number of staffs so removed and replaced by signing the entry made by the telegraph lineman in the train register, and inserting the time at which the transaction takes place. The entry must also be signed by the station-masters in the train register at their respective stations. The telegraph lineman must be specially careful that he does not lose any of the staffs in the process of transfer; and, in order that the signal-man at each end of the section may be assured of this, the person in charge at the end of the section from which the staffs are removed must send with the lineman a note stating how many staffs are being removed, and how many are left in the instrument. This note must be given to the person in charge at the other

end, who must see that the number of staffs brought by the lineman corresponds with the number stated in the note, and that the total number is accounted for, and make this clear to the signal-man. He must then send a telegraph or telephone message stating that the number is correct. When the staffs are replaced the instrument must be tested as provided by the rules.

When the staffs are reduced to four the signal-man, before sending for the lineman, must judge in what position the next few trains will place him, and he must defer sending for him until he is certain that his staffs will go on decreasing. It is important that when sending for the lineman he should be told for which section the staffs are running short. If the lineman arrives by train, and is going forward by the same train, he must not take out the surplus staffs until the signal-man has first obtained in the ordinary way the staff that the train will carry.

INSTRUCTIONS GOVERNING THE OPERATION OF THE TRAIN STAFF SYSTEM ON THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY, BETWEEN SAVANNA AND SABULA JUNCTION.

The Chicago, Wilwaukee & St. Paul Ry. has a single track part of its line, between Savanna, Ill., and Sabula, Ia., operated by the train staff system. The distance is about three miles, and includes the bridge over the Mississippi River. The traffic is heavy, being rarely less than 50 trains per day, but it has not been thought expedient to double-track the line or to replace the bridge with a double-track structure. Block working on the Webb and Thompson train staff system has therefore been adopted in order to ensure facility and safety in handling the traffic. Facility in handling the traffic is of special importance in this case, the train movements being very irregular.

The working of the train staff system is effected by the erection of a train staff pillar in the block signal offices at Savanna and another in the signal office at Sabula Junction; each pillar is in charge of the telegraph operator on duty. The

two pillars are electrically connected, and it is impossible to operate one without the knowledge and co-operation of the operator in charge of the other. Each pillar is furnished with ten staffs for moving trains under absolute block. For moving trains under permissive block one pillar is furnished with one permissive train staff and six permissive tablets in addition to the ten regular staffs. The other pillar is fitted for the reception of the permissive staff and tablets which may be in whichever pillar necessity requires.

A staff or tablet in the actual possession of the engine-man is the necessary authority for the movement of a train in either direction. Only one staff can be taken from a pillar at one time. When a staff has been withdrawn from one pillar another cannot be withdrawn from either until the staff previously removed has been placed in the same pillar or the one at the other end of the block. Absolute block in both directions is therefore effected.

When permissive block is to be used the permissive staff is withdrawn from the pillar and used to unlock the box containing the permissive tablets. One tablet is given to each train, the last train taking the remaining tablets, if any, together with the permissive staff, or the permissive staff alone, if all the tablets have

been used. Until the permissive staff and all the tablets have been placed in one of the pillars, no staff can be taken from either pillar.

The following are the rules under which the operation is carried on:

1. No train or engine shall be run in either direction between Savanna and Sabula Junction unless the engine-man has in his possession a train staff or permissive tablet, which must be handed him by the conductor of his train and retained by him as long as his train or any portion of it is in the block. The possession of a staff or tablet is authority for the engine-man to proceed regardless of opposing trains, provided the block signal is in proper position and the conductor's signal has been given.

2. The conductor of a train or engine is the only person authorized to receive a train staff or tablet from the operator in charge, and must personally hand the same to the engine-man. On arrival at the opposite end of the block the conductor must obtain the staff from the engine-man, and if all his train is within the station limits, personally deliver to the operator.

3. In case a train parts or it is necessary to double, the train staff or tablet must be retained by the engine-man until all the train is clear of the block.

4. Before accepting a permissive tablet from the operator, conductors must know that the operator has the permissive staff in his possession.

5. Under no circumstances will a staff or tablet be transferred from one train to another. It must invariably be delivered to the operator strictly in accordance with these instructions.

6. Engine-men who receive a regular staff will understand that all trains are clear of the block. They must be careful to note whether they have a regular or permissive staff. There is but one permissive staff. It differs in shape from the regular staff; is painted green and is marked "permissive staff."

7. Engine-men who receive the permissive staff or a tablet will understand that the preceding train has not cleared the block, and must proceed cautiously. The block signal will be left at danger to trains running under permissive block, and the possession of the permissive staff or tablet is authority to pass the block signal at danger.

8. When two or more engines are coupled together the engine-man of the last engine, or the engine attached to the train, must carry the train staff or tablet, but

the engine-man of the other engine must know that he has the staff or tablet before proceeding.

9. In case of failure of the staff apparatus, trains will be moved by special telegraph orders, as per general rules.

10. The upper arm or light of the block signal posts at Savanna and Sabula Junction governs Chicago & Council Bluffs division trains. The lower arm or light governs Dubuque division trains.

11. All rules relating to the protection of trains are in force, and the general rules are only modified by the special instructions herein.

12. The telegraph operators at Savanna and Sabula Junction will have charge of the train staff pillars. The operator on duty at Sabula Junction will act as bridge dispatcher and have control of the traffic. He must keep himself informed in regard to the position of trains and be prepared to give important trains the preference.

13. When a train is to enter the block, under absolute block, the operator at the station from which it is to start will signal to the operator at the other end of the block, by one tap of the bell, that he wishes to withdraw a staff. The opera-

tor so signalled will reply with one tap of the bell and hold his key down until the needle shows, by returning to a vertical position, that a staff has been withdrawn, when he will release the key and turn the left indicator to "staff out."

14. On receipt of the bell tap the operator who is to withdraw the staff will turn the right hand indicator to "for staff," and withdraw a staff. When this is done he will turn the left hand indicator to "staff out" until the needle returns to a vertical position. The right hand indicator will return automatically to "for bell" when a staff is withdrawn.

15. When permissive block is to be used the operator in charge of the pillar which holds the permissive staff and tablets, will proceed in the same manner to withdraw the permissive staff as in the case of a regular staff, except that two taps of the bell will be used and acknowledged. The permissive staff will be used to unlock the box containing the permissive tablets and retained in the possession of the operator as per rule No. 19.

16. When a staff or tablet has been delivered to the conductor the proper block signal will be displayed, and on the departure of the train a record of the

time of departure will be made on the block sheet and reported to operator at the other end, who will enter on his block sheet.

17. On arrival of the train at the opposite end of the block the conductor will deliver the staff or permissive tablet to the operator in chargo, who will, after seeing the markers, record the arriving time of the train and report to the operator at the other end who will enter on his block sheet.

18. The operator receiving a staff will, after placing it in the pillar, turn the left indicator to "staff in." When a tablet is received the operator will not turn the indicator to "staft in" until all the tablets and the permissive staff have been received, the tablets locked in the box and the permissive staff placed in the pillar.

19. The operator sending trains forward under permissive block must retain the permissive staff to be forwarded by the last train. If all the tablets have not been used in forwarding trains, the last train to use permissive block must take the remaining tablets and the permissive staff.

20. As conductors cannot accept tablets unless they see the permissive staff in the possession of the operator delivering the tablet, operator will keep the permissive staff in view and call the attention of conductors to it.

21. When the block is clear, the block signal should be placed at safety after the delivery of a staff to the conductor and immediately placed at danger on the departure of the train.

22. When using permissive block the block signal should remain at danger.

23. The operator must not deliver a staff or tablet to any person except the conductor of the train to enter the block.

24. Operators must not deliver a staff or tablet received from a train to another train until it has been passed through the pillar in strict accordance with the rules.

25. Under no consideration will an operator place a staff in the pillar or report a train to the operator at the other end as arrived until he has positively seen the marker and knows that all the train is inside the station limits.

26. Permissive block must not be used for the movement of passenger trains, except in case of emergency.

27. In case it is necessary to transfer the permissive staff and tablets from the pillar containing them to the other pillar, a train may be sent forward with all the permissive tablets and the permissive staff.

28. Should the staff apparatus fail the bridge dispatcher will move trains in the name of the east division train dispatcher as per general rules relating to the movement of trains by telegraph.

Staff System Code.

BY BELL.

2 Taps, Unlock.
3 " Staff in.
4 " Permissive Tablet Received.
5 " Permissive Tablets and Staff in.

BY TELEGRAPH.

22	C. & C. B. Train No.....west, ready.	To be used by Savanna to notify Bridge Dispatcher that a train is ready.
33	Dubuque Train No.....west, ready.	
55	Unlock for C. & C. B. Train No.....East.	To be used by Bridge Dispatcher to direct Movement of Trains.
77	Unlock for Dubuque Train No.....East.	
222	Let C. & C. B. Train No.....proceed under "absolute" block.	
333	Let Dubuque Train No.....proceed under "absolute" block.	
99	Let C. & C. B. Train No.....proceed under "permissive" block.	
121	Let Dubuque Train No.....proceed under "permissive" block.	
235	Deliver all remaining tablets and the Permissive Staff to Train No.....	
58	Hold west bound train.	

The operator at Savanna must obtain authority from the bridge dispatcher for each train to go forward under permissive block before delivering the tablet or staff to the conductor.

Operators must keep a correct record of the movement of trains on the sheet provided for that purpose. On that sheet must be entered the time each staff or tablet is delivered, opposite the number of the train to which it was given, and the sheet must show whether the train went forward under absolute or permissive block.

CHAPTER XIV.

APPENDIX.

USE OF BLOCK SIGNALS FOR THE PROTECTION OF MAINTENANCE-OF-WAY OPERATIONS.

Following are the instructions of the Midland Railway of England, for protecting maintenance-of-way operations by the use of fixed signals:

"When it is necessary to stop trains the foreman must supply the flagman with a red card, lettered as under, properly filled up, and the flagman must, on arriving at a signal box (signal station) hand the card to the signal-man, who must retain it, and act upon the instructions it contains until the card is withdrawn by the flagman under instructions of the foreman:

(Form of card to be used.)

Midland Railway.

TRACKMAN'S DANGER CARD.

The signal-man on duty at .....
is required to STOP all * ..... *trains until this card is withdrawn by the flagman who hands it to him.*

[*Signed*]

.....

Foreman.

TIME THIS CARD WAS HANDED TO MAN IN SIGNAL-BOX.

..... *hours* ..... *minutes.*

Date .....

* Insert "up" or "down," as the case may be.

(Form of card to be used.)

Midland Railway.

TRACKMAN'S CAUTION CARD.

The signal-man on duty at.....
is required to CAUTION all * .....*trains until this card is withdrawn by the flagman who hands it to him.*

[*Signed*]

.....

Foreman.

TIME THIS CARD WAS HANDED TO MAN IN SIGNAL-BOX.

.....*hours*.....*minutes.*

Date.....

* Insert "up" or "down," as the case may be.

"When it is necessary to 'caution' trains the foreman must supply the flagman with a green card, lettered as under, properly filled up, and the flagman must, on arrival at a signal box, hand the card to the signal-man, who must retain it and act upon the instructions it contains until the card is withdrawn by the flagman under the instructions of the foreman.

"The flagman must remain near the signal box, and conspicuously exhibit a proper hand signal, so long as trains have to be stopped or cautioned; and, when recalled by the foreman he must obtain the card from the signal-man, and return it to the foreman.

"When the flagman has handed the red or green card, as the case may be, to the signal-man, he need not place any detonators (torpedoes) on the line; but he must do so in all cases when the company's regulations require it, when he is signalling independently of the signal-man, that is, when in going back the prescribed distance he does not reach a signal box.

"Cases of emergency may occur where it will be necessary to stop or caution trains before a card can be procured, and signal-men must therefore pay attention to any instructions given by trackmen, whether they then present a card or not.

"When men in charge of the working of fixed signals are instructed by trackmen, in accordance with the rules and regulations to caution trains, they must keep their fixed signals applicable to the trains that have to be cautioned, at 'danger,' until the speed of the approaching train has been sufficiently reduced, and the train is near to the home signal; the home signal must then be lowered to allow the train to pass, and a green hand signal must be exhibited to the engine-man."

The Erie Railroad uses the above regulations, practically, with the additional precaution of giving the engine-man a written notice where the train is permitted to proceed under "caution," stating the location of and the kind of work that is being done. These instructions apply to bridge men and all others whose work may in any way obstruct the main tracks.

ERIE RAILROAD CO.'S RULE FOR PILOT-WORKING WHEN ONE TRACK OF A DOUBLE TRACK IS OBSTRUCTED.

"Whenever there are two tracks in use, all trains must always (unless specially directed by the superintendent, or unless, from some cause that track is not

passable) take the right hand track; when the right hand is obstructed, and it becomes necessary to flag trains from one cross-over to another, upon the left hand track, around such obstruction, the superintendent shall assign the duty of running trains by flag to a conductor, who shall use an engine and crew for that purpose; and it will be the duty of such conductor to see that flagmen are properly stationed, and to notify trackmen and others who may be working on such left hand track, so that absolute safety may be secured before permitting trains to cross from the right hand to the left hand track. A general order to conductors and engine-men to flag themselves on the left hand track from one cross-over to another must not be issued. This order must not be construed as prohibiting conductors from flagging themselves on the left hand track if the right hand track be obstructed, when from a break in the telegraph wires, or from other causes, they are unable to communicate with the superintendent for instructions."

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